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EDITORIAL.

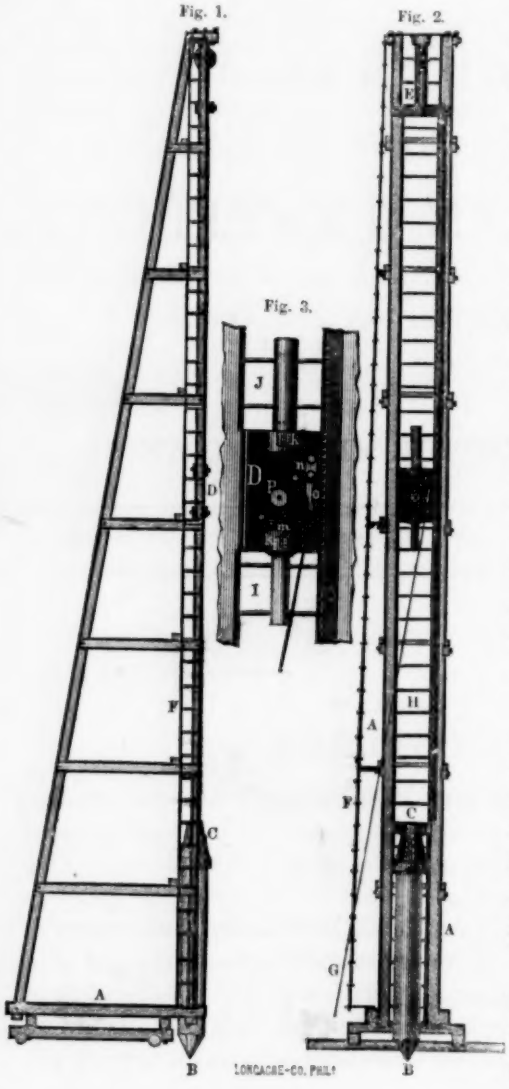
ITEMS AND NOVELTIES.

Gunpowder Hammer and Pile-Driver.—At a late meeting of the Institute, there was exhibited a gunpowder hammer, invented and constructed by Mr. Thomas Shaw, of this city. In describing the apparatus, Mr. Shaw said:—

Among the first and most useful mechanical instruments is the hammer; but the muscular effort necessary to throw the ordinary hammer, is too expensive to permit this mode of operation to be universal: hence other sources of power have been called into requisition, such as wind, water, and steam, and it is now proposed to add gunpowder to the list.

In the introduction of gunpowder for operating hammers, several advantages over all other sources of power are secured.

1st. In the employment of a concentrated fuel combined with a sufficient supply of oxidizing materials to make its combustion independent of artificial or natural draft.



2d. In the completeness with which the principle of expansion that can be brought into play, without cut-off valves or complications of machinery, and as it is only at high pressures that the value of expansion becomes prominent, we here have it to the fullest extent.

3d. In the readiness with which the machine can be started. Its going into action being simultaneous with the ignition of the fuel, and the immediate cessation in use of fuel with the stoppage of the work.

4th. In the simplicity of the machinery. For while the gunpowder hammer is the most powerful, it has not the tenth part of the complications of other hammering appliances.

5th. In its controllability. For this most powerful of all operative forces can be regulated by a child.

6th. In economy; for it is less expensive than other machines, because the fuel is employed to the best possible advantage, and

because the heat is not radiated and lost from innumerable surfaces.

The *modus operandi* of bringing about these results is as follows: A weight or hammer is suspended between vertical guides, and is provided on its under side with a plunger that fits into the bore of a cylinder held between the same guides beneath the hammer. It is intended that the cylinder should rest upon the object to be pounded, and that the hammer should be held by a pawl, which catches into a rack secured parallel with the guides. The pawl is released from the rack by a cord connected with the same, whereupon the hammer is allowed to fall. A small amount of powder is placed in the cylinder; the hammer falling, forces its plunger into the cylinder, compressing and heating the air, which explodes the powder, forcing the hammer up again, and forcing the cylinder downward with an effect fully eight times as great as from the fall of the weight alone. At the top of the guide-frame is suspended a plunger, which fits into a cylinder in the top of the hammer, thus making an air-chamber to receive the blow of the hammer in case of an over-charge of powder, that no danger may result to the machine.

I will here mention that this device is very useful as a drop-hammer, being complete within itself, and always ready for work, independent of other source of power.

Also, as a forge-hammer, the continued pressure of the blow gives this hammer evident advantage over all others for large work; for it will be observed, that the pressure is continual while the hammer is moved from a state of rest through a space equal to the length of the bore of the cylinder, which, in a large hammer, is a distance of forty inches, whereas, in other methods of hammering, the pressure is lost so soon as the momentum is overcome, in spattering the surfaces of a large mass of metal.

From this it results that large masses are never homogeneous to their centres, and the outer shell is put under a severe, crushing strain, while the inner metal is under a like tensile strain, and thus a great loss of effective resistance occurs.

Wrought metal should be kneaded and worked, as dough, to bring out its highest qualities. An hydraulic press would be the most suitable appliance, but for its slowness, which involves great loss of heat before the metal is fully manipulated.

It is here that gunpowder comes to our aid, giving the continued

pressure of the hydraulic press combined with the rapidity of the hammer, and thus renders possible the working of iron under the hammer like putty under the hands. The advantages of thus *pressing* metal are too prominent to need enumerating.

The model which was exhibited on this occasion had a ram of about three pounds weight, and a fall of eight feet. The charge employed was half a grain of white gunpowder, made of chlorate of potash, ferrocyanide of potassium, and sugar.

With a larger instrument, whose ram weighed seventy-three pounds, with a fall of twenty feet, the charge was 14 grains of the same powder.

A pile placed under this, and driven one-quarter inch at a stroke by the fall of the ram, without the use of powder, was driven two inches at each stroke, when the powder was used, and after being driven, with a square end, into hard ground, to a depth of four feet, showed no splitting or injury to its head.

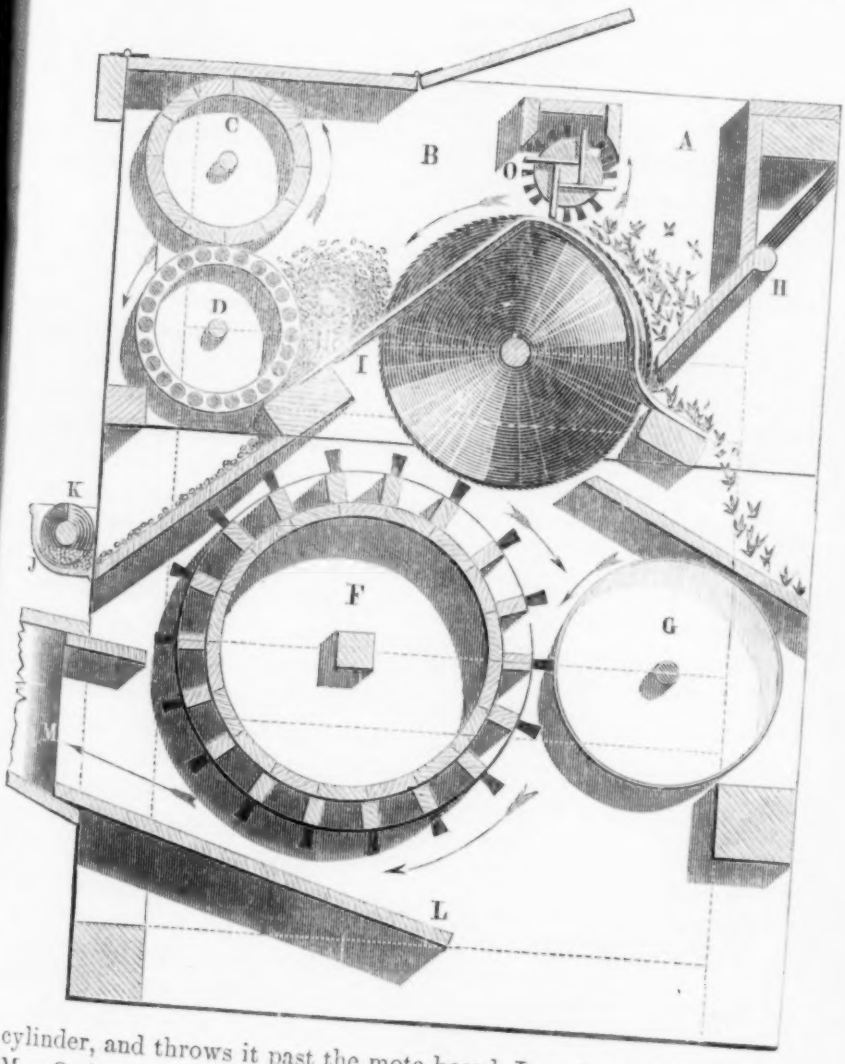
The Duplex Engine of Henry R. Worthington.—In answer to inquiries received from various quarters, as to the engine referred to by Mr. Robert Briggs, in his letter published in the *Journal*, p. 16, we would state that the engine whose performance is there ranked with that of the Cornish type, is what may be fully and historically indicated by the title, Worthington Wolfe Annular Expansive Duplex Engine. As we are referring to this article, we will take occasion to correct a typographical error which was made after revision of the proof. The numerator of the fraction expressing the maximum velocity of the plunger, should be not K, but the Greek letter π, which expresses of course, the relation of a circumference to its diameter, 3·14159.

Cotton Gin, by Richard R. Gwathmey. At the last meeting of the Institute were exhibited the above apparatus with specimens of its work.

Its structure and operation will be clear on examination of the following cut and description.

The cut represents a transverse section of the Champion Gin and Huller. The cotton is dropped into the front box, **A**, where the saws in operation carry it into the breast box, B, the hulls being constantly kept back by the hulling roller, O. The cotton roll which forms in the breast, B, is carried and kept intact by the two carrying rollers, D and C, the lower one of which is open or slatted, and the upper one a continuous circumference. The brush,

F, takes the cotton off the saws, and throws it on the wire gauze cylinder, G, which allows the dust, but not the cotton, to pass through it. The brush, F, gathers the cotton again from this wire



cylinder, and throws it past the mote board, L, and out of the flue, M. O shows the ribs between the saws, and H shows an inclined sliding bottom to adjust the hulling operation. The seeds pass out under the roller, D, fall into the trough, J, and are carried off by the screw, K.

The saws are so arranged as to run in a reverse direction to those of all other gins. From this new adjustment, a great advantage is claimed, namely, that of procuring the lint from the seed cotton "in the boll," without cutting or breaking the hulls or napping the lint.

It must be obvious to all who have any experience of the mode of preparing cotton for the market, that a machine which will accomplish this without any additional power required to work it, must enable the planter to cultivate and gather in much larger crops with the same number of hands, than he could possibly do by relying upon the capacities of ordinary gins, adopted only for work upon cotton previously picked from the hull.

To show the financial advantages claimed for this invention a short calculation will suffice. In the usual way of hand-picking cotton, from 150 to 200 pounds in the seed, constitute an average day's work of a hand. But when the boll and hulls are pulled or raked off, from 600 to 800 pounds a day can be carried from the field by a single hand.

Supposing the cotton to be picked from the field by the hand, in the usual way, at the rate of 200 pounds to the hand per day, the amount in 30 days would be 6000 pounds. Allowing two-thirds of this weight for the seed, the amount of cotton wool, after ginning, would be 2000 pounds of merchantable cotton, or 5 bales of 400 pounds each. This at 20 cents per pound would yield the planter $400 for thirty days picking of one hand.

But where a Gwathmey Gin is employed, which will gin the cotton thrown into the hopper, *hulls and all*, four times the amount can be gathered from the field by one hand in the same time, that is to say, 24,000 pounds in thirty days. Deduct from this gross weight, 10 per cent. for the hulls, and two-thirds of the remainder for the seed, and the yield of clean cotton wool to the planter would amount to nearly 20 bales, which at 20 cents per pound would give $1,600 for the product of one hand's picking for thirty days.

The Suez Canal.—At the last meeting of the *Institute*, the following remarks were made on this subject by Mr. Robert Briggs.

The last and best report on the progress of the work on the Suez Canal, is one just made by Mr. John Fowler, formerly President of the Institution of Civil Engineers, in London. Although very apparently made in the English interest, it will be found, upon close examination, to present a full and favorable report of the present condition of the undertaking.

Notwithstanding the elaborate reports of the French engineers, a translation of the last of which has been read by the Secretary this evening, it does not seem generally understood how far the canal has proceeded, or what the real extent of the enterprise consists in.

I will therefore state for those who are curious to know, that the total length of the canal is 99½ miles.

Its northern end is at Port Said, which is an artificial port, made for the canal, by projecting two jetties into the sea from a point on a long, narrow beach, which skirts the coast of the Mediterranean at the easterly end of the delta of the Nile. This beach, like the beaches on the shore of New Jersey, encloses an inlet or lake. The first 37 miles of the course of the canal lies in the Lake Menzaleh. The average depth of water was but four or five feet, while the depth of the finished canal is to be 26 feet. Lake Menzaleh is a stagnant, vile water, a little salter than the ordinary water of the sea, because of the rapid evaporation which occurs in this nearly rainless district. Across this lake the canal has been dredged until a clear water way of 15 or 16 feet appears to have been attained everywhere, and the full excavation is going on by means of dredging machines more rapidly than was anticipated, when the promise of completion in October next was made. After passing through Lake Menzaleh, the canal next passes higher ground between El Ferdam and Lake Timsah.

The excavation in some part of this section of 9½ miles, seems to have been about 134 feet (some statements make it only 87 feet, total cutting). This section of the canal was opened last November, and the water admitted into the depressed basin of Lake Timsah. Lake Timsah, within the historic period, has been a fresh water lake, but it has been long dried up, probably about 1,400 years.

The course of the canal, with only the requirement of dredging out the bottom, follows the lake, and the navigable terminus for vessels under 16 feet draft, is at the southerly end of the Lake Timsah, 54 miles from the Mediterranean.

Then there follows through a ridge 7½ miles of cutting, which is now approaching completion, some portions being excavated to the full depth, while others are ready for the application of the dredging machine.* When these 7½ miles, which have been considered the

* Since this was stated, the waters of the Mediterranean have been permitted to flow through this section into the Bitter Lakes.

greatest task, shall have been completed, water can be let into the Bitter Lakes. The course of the canal follows that of the valley, or depression of the Bitter Lakes.

The present surface of the ground of this valley where the course of canal is projected, is nearly all of it 26 feet below the level of the sea. It is probable that the depression of solid ground is even more, as excavations of 8, 10, 12, or in some places 30 feet, show the earth to be about three-quarters soluble salts.

Twenty-three miles of canal are thus formed ready for use. At the southerly end of the Bitter Lakes, the ridge of Chalouf, about 5 miles, with a sand-stone bottom, presents itself. The open excavation of this cut has engrossed more of the labor of the workings from on the canal, than any other section the past two years, and it is more nearly completed than any other part of the heavy work to the full depth. From this point, 11 miles to Suez, the ground is but little above the Red Sea, and on this last section the least work has been done.

There are really now only 16½ miles to be opened, or not ready for the water to flow into.

At the deep cuttings on either side of Lake Timsah, there has been trouble by the blowing in of sand, which will continue until the sand surface has arranged itself, and will probably always continue to a lesser extent. The Company are planting trees and shrubs on either bank for some distance from the canal. Mr. Fowler does not assert that the quantity of sand which will silt into the harbor of Port Said or blow into the canal will be an insurmountable detriment, but he estimates the largest quantity he can suppose as such a quantity, that "considerable expense," at the Port and one or two powerful dredges at Lake Timsah will be always needed. Again, Mr. Fowler estimates the effect of a strong current, which may arise from the evaporation of water in the Bitter Lakes. As no similar current supplies the far larger extent of water of Lake Menzaleh, it is very improbable that any quantity approaching the 250,000,000 of cubic feet of water daily will be evaporated in the Bitter Lakes. With but one or two feet depth of water, evaporation has been found to go on rapidly, but with greater masses of water, the rate of evaporation is much diminished. The Janks of India by no means corroborate any such estimate.

We may feel sure that the canal is rapidly approaching completion. Before the middle of May, the water of one, if not of both

seas, will be rushing into the depression of the Bitter Lakes, which with fair allowance for evaporation, it will take three months to fill. The great delay of the opening being in this filling of the Bitter Lakes. Whilst the estimates of the difficulties present and to come, in the engineering point of view, are, if not exaggerated, at least fully stated in Mr. Fowler's report, his estimates of the business capacity and the business opportunity of the canal are as little favorable as it is possible to assume. Were general engineering operations to be considered only from every possible point of failure, and their probable returns be estimated by the least assumable capacity, and the smallest probable use, but few engineers would be needed. England has not generally learned from her engineers how not to do everything.

The truth is, the canal has been undertaken in the face of what every good Englishman considers the interest of England, and more than that, without the aid of English engineers or English capital. Could the prices of the debentures be brought low enough, more favorable reports would appear in London.

Long Span Bridges.—We are indebted to the kindness of Prof. De Volson Wood, for the following interesting summary:—

TABLE OF BRIDGES HAVING LONG SPANS.

TRUSSED BRIDGES.

NAME OF BRIDGE.	Total length in feet.	No. of Spans.	Longest Span.	REMARKS.
Schaffhausen, Switzerland	365	2	193	Weisbach Mech. Vol. II p. 283.
Trenton, N. J.	880	5	200	Wooden arch trussed Haupt on bridge construction p. 242.
Columbia, Penn'a	5,280	29	200	Burr's—destroyed during rebel invasion, 1863. Mahan. p. 240.
Newark Dyke, Eng.			240½	Longest span of Warren's Girder. Jour. Frank. Inst., Vol. 26, 3d Series, p. 156.
Essex, Mass.	250	1	250	Mahan, Civ. Eng., p. 238.
Chepstow, Eng.	606	4	306	Queen Past—Theory of Bridges—Weak.
Noget, E. Prussia	374½	2	321	Jour. Frank. Inst. Vol. 39, 3d Series, p. 230.
Upper Schuylkill		1	340⅓	Mahan, p. 237.
Louisville Bridge, Over Ohio River	5,301	25	370	Flak's Truss—Report of Company.
Wettingen, Germany	390	1	390	Erected in 1778. Longest span of wooden truss on record. Weisbach Mech. Vol. II. p. 83.
Dirschau, Prussia	2,383½	6	397¼	Iron Lattice. Jour. Frank. Inst, Vol. 30, 3d Series, p. 230.
Kuilmburg, Holland			515	Longest span trussed bridge. Official Rep. 1866.
Derry, designed by Claus (never built)		1	900	Proposed wooden structure. Weis. Mech. Vol. II., p. 84.

TUBULAR BRIDGES.

NAME OF BRIDGE.	Total length in feet.	No. of Spans.	Longest Span.	REMARKS.
Conway Eng		1	400	Civ. Eng. Jour. 1848.
Britannia, Eng	1,513	4	460	Tubular Bridges by Dempsey. Traite de la Construction des Ponts Metalique Pl. X.
Victoria, at Montreal, Canada	10,284	25	330	Hunt's Merch. Mag. Vol. XXXI., p. 504; 24 spans are each 242 feet.

ARCHED BRIDGES.

NAME OF BRIDGE.	Total length in feet.	No. of Spans	Longest Span.	REMARKS.
Neuilly (over Seine)	more than 640	5	128	Mahan. p. 225.
Teff, South Wales		1	140	Failed by rising of the crown. Woodbury on the arch. p. 432.
London Bridge,	784	5	152	Woodbury, p. 432—for railroad purposes.
Rica, Ayr			180	Jour. Frank. Inst., Vol. 39, p. 231.
Chester or Grosnover			200	Mahan, p. 228.
Great Washington Aqueduct			200	Sc. Am. 1860, p. 86. Cast iron, by Rennie.
Southwark			250	Smile's Lives, Eng., Vol. II., p. 188.
Trizzo Adda	251	1	251	Longest stone arch on record. Treatise on Bridges, Weale, Vol I. p. 48.
St. Louis Bridge	1,509	3	515	Not yet built. The arch to be of steel Rep. by the Co. 1858
Proposed bridge over the Thames, by Telford		1	600	To be made of iron. Weisbach, Vol. II., p. 86.

SUSPENSION BRIDGES.

NAME OF BRIDGE.	Total length in feet.	No. of Spans.	Longest Span.	REMARKS.
Niagara Carriage Bridge		1	1,264	Sc. Am. Vol. XX., p. 218. This bridge is about a mile below Nigara Falls.
Cornwall (proposed to be built across the Hudson River, 42 miles above N. Y. City	2,499	1	1,600	Jour. Frank. Inst., Vol. LVII., p. 165.

NAME OF BRIDGE.	When Built.	Span.	REMARKS.
Douro, at Oporto	1842	558	Sup. to Weale's Bridges, p. 144.
Menai, Eng.	1825	580	Chain cable. Mahan's Civ. Eng. p. 255.
St. Johns, N. B.	1852	622	Sc. Am. June 19th, 1852.
Nashville, over Cumberland	1850	656	Destroyed by Rebel Gen. Floyd, Feb. 1862. Sc. Am. Mar. 30th, 1850.
Pesth, over Danube	1849	670	Total length, 1250. Jour. Frank. Inst., Vol. XVII., 3d Series, p. 300.
Niagara Railroad Bridge	1854	822	Jour. Frank. Inst.
Fribourg, Switzerland	1834	870	Jour. Frank. Inst. Vol. XXIII., 2d Series, p. 141.
Lewiston (7 miles), below Niagara Falls	1856	1,043	Sc. Am. June 1st, 1861. Blown down, Feb. 1864.
Lexington and Danville Railroad Bridge	1856	1,220	Jour. Frank. Inst., Vol. XXXIX., 3d Series, p. 230.
East River Bridge, N. Y. City		1,600	Proposed. Jour. Frank. Inst, Vol. LXXXIV., p. 243.

Electrical Induction.—Some novel and curious applications have been made by Sir William Thompson of this fertile principle, which has already received so many important developments, among which the Holtz machine is perhaps the most remarkable.

In the first place, this distinguished student of electric science and successful inventor of delicate instruments for telegraphic signaling and measurements, describes an instrument for developing electricity by the action of drops of water. It is arranged essentially, as follows: water is made to flow in a series of drops from the extremity of the pipe, B, surrounded by the cylinder, A, which is charged feebly, say with negative electricity. Each drop as it is about to fall from the pipe, and projects beyond the lower edge of A, acquires a negative charge by induction, which it carries to the funnel, C, and which may, from it, be conveyed to, and stored in, a Leyden jar connected therewith.

Fig. 1.

Following out the principle here indicated, (which has also been applied to the development of electric charge by the action of a lamp flame,) Sir W. Thompson has arranged another machine intended especially for transmitting signals on the Atlantic cable, though capable of many other useful applications.

A wheel of vulcanite, with a large number of pieces of metal attached to its rim, is kept rapidly rotating round a fixed axis. These pieces of metal called carriers, are very lightly touched at opposite ends of a diameter, by two fixed tangent springs. One of these springs is connected with the earth (called the earth spring), and the other (the receiver spring), is connected with an insulated piece of metal called the *receiver*, which is analogous to the prime conductor of an ordinary electrical machine.

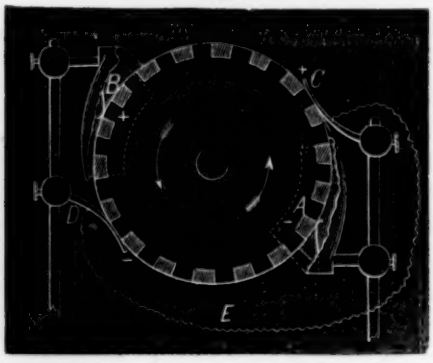
The point where the earth spring comes in contact with the carriers, is exposed to the influence of an electrified body (generally a piece of metal, insulated), called the *inductor*. When this is negatively electrified, each carrier comes away from contact with the earth spring, charged with positive electricity, which it gives up, through the receiver spring to the receiver. The receiver and inductor are each hollowed out and are properly placed to surround as nearly as may be, the points of contact of the corresponding springs.

The inductor must be kept constantly electrified. This is effected

by an adjunct, called the replenisher. This consists of an insulating wheel, with inlaid metallic blocks, revolving, as in the former case, within two inductors, A and B, and having also two conductor springs, C and D, in contact with it at the points where in its rotary motion the blocks of metal come out of the inductors.

The inductors, by means of springs, also communicate with the metal pieces while these are inside of them. Suppose, now, one inductor, A, to be charged with negative electricity, while the other, B, is neutral. The first can communicate no charge to the parts of the wheel within it, because they *are within*, for statical charge is confined to *outer surfaces*. As, however, the blocks pass beyond the edge of the inductor, A, they encounter the adjacent conductor, C, which is charged by induction from the *outside* of the inductor, so as to be positive, and to render the other conductor spring, D, which is connected with it by a wire, E, negative. The blocks thus pass away from this first conductor, A, with a positive charge, which they carry round and yield to the other inductor, B, which is thus made positive, and by its action on its conductor spring, D, increases the charge of the other one, C, and causes the blocks passing away from itself to carry negative charge to the first inductor, A. These inductors being connected with those of the other machine, keep them charged.

Fig. 2.



When the machine is started, bright flashes and sparks begin to fly about in different parts. This machine was very small, intended to be run by the clockwork of an ordinary Morse receiving apparatus. No doubt, much greater effects could be obtained with an enlarged apparatus.

Spectrum Lines—a new method of illustrating them. At a late meeting of the American Institute, Professor E. C. Pickering, of the Massachusetts Institute of Technology, employed the following method to illustrate his paper on Spectrum Analysis. A sheet of black lace, one and a half feet broad, and three feet high,

was suspended as a screen, and upon it was thrown a continuous spectrum from a magnesium light, arranged in the manner first developed for the electric light, by Prof. Cooke, of Cambridge, except that only one bisulphide of carbon prism was used. The spectrum covered the entire lace screen, the curvature of its lines being corrected by an opposite curvature of the opening through which the light passed. Upon this black lace, were attached a number of white paper strips, so arranged as to occupy the places of the bright lines in seven different spectra, such as those of sodium, potassium, rubidium, cœsium, &c. These being illuminated by the variegated light of the continuous and broad spectrum, received and reflected each the color corresponding to its position, and therefore (their adjustment being accurate), that which actually belonged to the band which it represented. The light falling between these paper bands was not of course reflected, and the appearance therefore was in each case (as in an actual spectrum), of bright colored lines on a dark ground. When, however, as in the case of potassium, the nebula of Orion, &c., a faint continuous spectrum is in fact combined with that of the bright lines, this also was represented by attaching in the required places, bands of white lace, which reflected enough of the colored light to produce a hazy spectrum, admirably imitating that of the substances or bodies in question.

The Spectrum of the Great Nebula in Orion, as seen with the Cambridge refractor, shows a faint continuous spectrum in addition to the three bright lines recognized by Miller and Huggins, and also another faint line in the vicinity of G, though its position has not yet been accurately determined. These facts, for which we are indebted to the observations of Prof. Winlock, of Cambridge, seem to indicate that this nebula is not composed of purely gaseous masses, but is made up of a number of gas-enveloped stars (like τ of the Northern Crown, during its eruption in 1864,) or, possibly, of a congeries of stars and gaseous spheres.

Should the new bright line near G prove to be coincident with the most refrangible line of Hydrogen (which coincides with a marked solar line a little less refrangible than G.) we shall have additional evidence of the presence, in this interesting object, of the omnipresent element—Hydrogen.

Lunar Volcanoes.—We observed, lately, in other journals, a notice that a lunar volcano in activity had been discovered by Prof. Winlock, of Cambridge. Through the kindness of Prof. Mayer, of

Bethlehem, we can now give the exact facts of the case. Observations with the great Cambridge refractor were made upon the moon by Prof. Winlock, with the view of bringing to the question of lunar volcanic activity a new class of evidence.

If any portion of the moon's surface were luminous through heat, it would yield a continuous spectrum without the Fraunhofer lines which distinguish light reflected from the sun. On observing the brightly-illuminated edge of Aristarchus, a spectrum was obtained which was marked by a bright streak running through its middle across the lines, whose width it seemed to diminish. It was, therefore, on the spur of the moment, suggested that this indicated the presence of self-luminous or highly-heated matter.

On further examination, it was, however, found that exactly the same effect was observed when the instrument was turned upon any other similarly brilliant point.

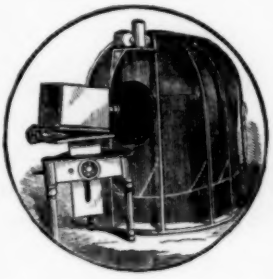
Petroleum in Place of Bisulphide of Carbon to Vulcanize India Rubber.—The use of the last-named of these substances in combination with chloride of sulphur has been common for many years in the process of vulcanizing, but is open to many objections, the most serious of which are, 1st. The great loss experienced from the extreme volatility of this liquid, and 2d. Its injurious effect upon the health of those inhaling its vapor, not to mention the disgusting nature of the odor it evolves when this is first perceived.

It has been stated, lately, that this last property is due to an impurity which may be removed; but the olfactory nerves very soon lose perception at all events, if its presence is continued. In view of all these considerations, however, it is evident that such a substitutions as is named above will be of value, if, as is stated, it proves practically successful.

Testing Machine.—A writer to "*Engineering*," remarks that in some tests which he witnessed with the Kirkaldy machine, a trammel used on the bar itself, showed a far less amount of extension under various strains, than was indicated by elaborate machinery and index attached to the instrument for this purpose. This is an important point to have in view in connection with such tests.

Photography at Night.—A few evenings since, some experiments were made at the salesrooms of Messrs. Wilson & Hood, with the apparatus devised by Mr. G. K. Proctor, of Salem, Mass., for the purpose of taking likenesses after dark.

The accompanying cut represents the arrangement, which consists of a light frame, from which is supported an oval inclosure of paper-cloth, of a highly reflecting character. The sitter being placed within, and a back-ground screen adjusted, a little magnesium is burned by means of a lamp, or otherwise, at the top, and its light diffused by reflection from the interior of the paper walls, enables a good negative to be made in 15 to 20 seconds, during which time the cost for light is about 9 cents. Many excellent pictures have been thus made by the inventor, who says that often the best part of his days' work is done at night. The efficiency of the arrangement consists in the *nearness* of the *light-colored walls*, to the sitter, by which much light is thrown upon him in various directions and in a diffused manner, thus avoiding the gloom and painful local intensity common to pictures by magnesium light in ordinary rooms, where the scattered light is lost before it can be reflected upon the sitter from the *distant* walls.



Trial of a Steam Road Roller.—A public trial was made at Rochester, on Friday, January 15, in the presence of a number of officers of Royal Engineers and others, of a powerful steam road roller recently manufactured by Messrs. Aveling & Porter, at their works, at Strood, and intended to be sent out to New York, to be used on the roads of the Central Park in that city. The engine was purposely tested under the most disadvantageous circumstances, with a view of fully developing its power, for which purpose it was made to ascend Star-hill, the steepest incline in the city, which has a rise of one in twelve. The entire surface of the roadway had previously been thickly covered with stones of the ordinary kinds used on macadamized roads. The steam roller commenced its work soon after 10 o'clock, and notwithstanding the increased difficulties it had to surmount, by 4 o'clock in the afternoon, it had made repeated ascents and descents of the hill, the entire surface of which was rolled completely smooth and fit for the passage over it of the lightest vehicles. In addition to other orders they have received, Messrs. Aveling & Porter, the patentees, have received directions from the Government to manufacture three of the rollers for India.

Editorial Correspondence.

ACID PROOF CEMENT.

Philadelphia, March 22d, 1869.

Mr. Editor:—Thinking that the following suggestion may be of use to, or improved upon by some of the readers of the *Journal of the Franklin Institute*, I offer it with these ideas for what it may be worth. It frequently happens that the chemist requires some means for protecting cork from the destructive action of vapors such as arise from boiling nitric acid. I think that the plan here mentioned, may possibly meet this requirement. Finding it necessary to connect a glass tube with a wide-mouthed flask, and in so doing to use a cork which was exposed to the action of the fumes from boiling nitric acid for several hours, I found the best preservative to consist of a coating of silicate of soda and powdered glass. The cork having been bored to suit the size of the tube, was soaked for two or three hours in a solution of silicate of soda, consisting of one part of commercial concentrated solution, to three parts of water. The tube was next inserted, and when dry, the cork was covered with a paste made by mixing the condensed solution of the silicate with powdered glass in such proportion as to form a mass of about the same consistence as that of putty. This is spread on the under surface, and then washed with a solution of chloride of calcium. It soon hardens, so I think it advisable to make the connection with the flask whilst the paste is in a plastic state, and to allow it to become solid before applying heat to the vessel containing the acid.

Corks protected in this manner, were but slightly acted upon, though remaining over the boiling nitric acid more than four hours, and over hot acid for ten. In some instances, when not entirely covered, the vapor softened the cork beneath the silicate to the depth of about a quarter of an inch, but the cement proved sufficiently strong to form a compact diaphragm, enabling the tube to be removed from the flask without danger of the fluid contained being contaminated. I would suggest also the application of this cement as a luting for chemical apparatus for general use, as I find that it remains unaffected even when immersed in strong nitric, sulphur, or muriatic acids. The immersion in these liquids was made whilst the plaster was still soft, with the only perceptible effect of hardening the same immediately. Yours, &c.,

Rob't. F. Fairthorne.

Civil and Mechanical Engineering.

BELTING FACTS AND FIGURES NO. II.

By J. H. Cooper.

(Continued from page 164.)

The Telo-dynamic System.

"For the transmission of power or 'work' to moderate distances, we have had, for ages, two main methods employed—the horizontal revolving shaft and the strap pulley—supposing, as is almost always the case, that what we need in the *form* of the transmitted work is *rotatory* motion; but these are only capable of transmitting work to extremely short distances, unless with the most serious losses or waste of power by the absorption of work of the motor in torsion and friction of the shaft, and in friction, rigidity and slip, &c., of the strap."

"For a mere dead pull, such as the alternate strokes needed to work a pump, work is, and has long been, transmitted to very great distances; as by the long lines of 'draw rods' used in mining regions for transmitting the power of a water wheel by means of a crank on its main axis, *pulling* during half its revolution to raise a heavy weight or 'balance bob' at the remote end of the line of bars; but a system of draw rods cannot economically be employed in producing rotatory motion at great distances.

"In recent days, the idea so clearly seen by Bramah has been realized upon a large scale by Armstrong and others, in the transmission of power by water pressure, or, as it has been called, by 'hydraulic connection;' and Armstrong has even perfected apparatus by which water pressure thus transmitted, through it might be, miles of pipe, may be converted into rotatory motion."

"Papin saw the possibility of transmitting power through pneumatic conductors, though if the accounts handed down be reliable, he did not succeed in realizing his notions. There can be no question, however, that power may be transmitted, either by exhaustion or by the condensation of air, for very great distances through tubes, and may be converted into rotatory motion at the remote extremity, or anywhere by the way. * * * * *

"In both these cases, like that of the hydraulic connection, however, unless the tubes bear a very large proportion in area to the demand for the current, whether of entering or of issuing air that transmits the power, the loss by the friction becomes very serious. The capital to be sunk in pipes, therefore, is large in relation to the power got, and both this expenditure and the waste of power increase directly with the distance of transmission."

"Meanwhile, however, there exists in actual use, and upon a large scale, another and a simpler apparatus for the transmission of power, in large amount and to very great distances, which has attracted, we may say, no attention as yet in this country. We refer to the system originated by Mr. C. F. Hirn, of Mulhausen, which has been called that of 'telo-dynamic transmission,' and some drawings indicative of which were shown as long ago as the Exhibition of 1862."

"Crudely stated, this method appears to the superficial observer to consist in nothing more than in transmitting the rotatory motion of one large grooved pulley, kept revolving by the motor, to another such pulley at a greater or less distance by the intervention of an endless wire or steel band, or wire rope, passing over both pulleys; and to the uninstructed observer the whole affair seems little else than the old 'belt and pulley,' a mere elongation of that commonplace 'wrapping connector.' The hidden principle involved, however, is something entirely different.

"If we suppose a band of round iron of one inch in diameter to be capable of sustaining a steady pull, without sensible alteration, of ten tons, and that the bar be pulled with this force endways, so that a point between the motor and the resistance moves at the rate of one foot per second, then it is obvious that the bar itself will be transmitting 'work' at the rate of ten foot-tons per second. A bar of half its diameter, or one-fourth its section, can only be strained to 2·5 tons, and at the same rate of 'end-on' motion, can only transmit 2·5 foot-tons of work per second; and so also of a bar one-fifth of an inch diameter, or one-twenty-fifth of the area of the one-inch bar, it can only transmit ·04 ton, and, at the rate of one foot per second, ·04 foot-tons of work. But suppose that the half-inch bar moves end-on at the rate of four feet per second, and that the one-fifth inch diameter wire moves at the rate of twenty-five feet per second, then, as work is made up of pressure, times velocity, all three bars, much as they differ in section and in absolute strain upon each, will transmit the same number of foot-tons per second:

i. e., shall all be capable at the resisting end of delivering forth equal quantities of motive power in equal times.' If, therefore, we increase the velocity of motion of the wrapping connector, which is intended to transmit a given amount of motive work in a given time, we may reduce its section, because we have reduced the strain upon it, and hence its total weight in the inverse ratio of the increased velocity. We may, in fact, to put an extreme illustration, reduce the one-inch round bar to an iron wire, as fine as a human hair, and yet (theoretically) get out of it at the resisting end our ten foot-tons per second."

"Now, this is just the principle which distinguishes Mr. Hirn's method from any common belt and pair of pulleys, and which he has shown can be carried into practical use with great advantage.

"At the motor, be it steam engine or water wheel, he places a tolerably large cylindrical-grooved rimmed iron pulley, revolving in a vertical or horizontal plane, to which he communicates rotation at a determinate and considerable speed. Round this he passes a thin wire, or a thin wire rope (which latter in practice he prefers), and this is led away to almost any reasonable distance (the limit is measurable by *miles*), where it is passed over another similar pulley, and returns back as an endless cord to the pulley whence it started. If the distance be more than a few hundred feet, or the intervening surface differ in level, &c., both limbs of the cord are supported and guided at intervals by guide pulleys, as few as possible, leaving the cords in the intervals between these to sag down into such catenary as the strains upon it and its own surplus strength may determine and admit. The periphery of the driving pulley may have an angular velocity as great as possible; the only limit, in fact, is that the speed shall not be likely to destroy the pulley by centrifugal force. The speeds that have been actually employed in the examples to which we are about to refer, vary from ten to thirty yards per second, at the circumference of the pulley. The pulleys themselves have been made of cast iron and of steel, and they have but one peculiarity of construction, and that is a highly important one. At the bottom of the acute V-shaped groove, going round the circumference, a little trough is formed, dove-tailed, in section, which is filled with a ring of softened gutta-percha let into it, and united at the returned ends. Against this, as the bottom of the V groove, the wire rope of transmission alone bears. It forms a seat for itself, and does not touch the sides of the V groove or other metallic

parts of the pulley. The same arrangement is adopted for the receiving pulley for the power at the remote end, and for all guide or supporting pulleys that may be necessary.

"The wire ropes are thus found to hold perfectly, and not to wear sensibly, for long periods.

"Previously to devising this form of pulley, Mr. Hirn had much difficulty from the wear of the wire ropes, and in other ways, and had tried, in vain, wood, copper, and other linings for the pulley grooves.

"Now, assigning a peripheral velocity to the motor pulley of thirty yards per second, it is obvious, upon the principles we have already stated, that for each horse-power that we require to transmit, we must visit a strain upon the material of the cord, moving at that rate, of $\frac{33000}{90} =$, say 366 pounds; and taking the breaking strain for average iron wire at 67,000 pounds per circular inch, and the safe strain at about one-half that, or say 33,000 pounds per circular inch, then $\frac{33000}{366} = 90$ nearly, or *a wire of one-ninetieth of a circular inch in area will transmit a horse-power per second.*

"The wire must have surplus strength, however, also, for the *loss* of power absorbed by the sources of loss in this method of transmission. These are: 1, the resistance of the air to the rotation of all the pulleys; 2, the rigidity of the wire rope in circumflexure of the two main pulleys, and through the change of angular direction at either side of supporting or guide pulleys; 3, the resistance of the air, by friction, to the passage of the wire cord itself through it; 4, the friction of the axles of all the pulleys.

"Where the distances of transmission are moderate, *i. e.*, within a few hundred yards, the actual result of experiments upon the large scale, as stated by Mr. Hirn, show that all these together amount to about $2\frac{1}{2}$ per cent. of the power transmitted. Where supporting and guide pulleys are required, there is to be added to this $2\frac{1}{2}$ per cent., which represents a *constant* resistance due to the motor and transmitting pulleys and rope merely, an *additional* resistance which *varies* with the distance, and has been found, with the usual amount of supporting or guiding pulleys needed for long distances, to amount to about 504 foot-pounds for each 1100 yards in length of the double cord. Thus we see that for short distances the transmitting wire need not be larger than one-eighty-fifth of a circular inch in area per horse-power; and for even such an extreme distance as upwards of *twelve miles*, we need only add one-

third to its total area, on account of all resistances due to uselessly consumed power.

"Enough has been said to show how attenuated may be the transmitting cord, and how light it may be.

"With two pulleys, each of twelve feet diameter, making 100 revolutions per minute, and with a wire cord of two-fifths of an inch in diameter, Mr. Hirn has found that 120 horse-power can be transmitted to a distance of 150 yards, with only a waste of power or useless effect of 2½ horse-power.

"The first attempt at practical application of this method was made as long ago as 1850, at Logelbach, near Colmar, at the ancient calico print works of M. M. Haussmann, established in 1772, but shut up from 1841. It was proposed to make the great concern into a weaving factory for cotton, but the immense scattered mass of buildings seemed to forbid the possibility of utilizing them, and yet placing the motive power at any one point. Shafting, as a matter of cost and of waste by distance, was out of the question.

"In this emergency Mr. Hirn first tried this method of force transmission, with a rivetted steel ribbon or band to each building from the engine-house. The band first tried was about two inches wide by one-twenty-fifth of an inch thick, and on wood-faced drums. The success of the *principle* was complete, but much remained to be discovered before the round wire cord and gutta-percha pulley solved all difficulty, and brought the principle to be a practical reality.

"Since the establishment of M. M. Haussmann's weaving mills on this plan, in 1854, M. Schlumberger has transmitted the power of a turbine at Staffelfelden about 90 yards; in 1857, at Copenhagen, 45 horse-power was transmitted to saw mills at more than 1000 yards distance from the motor; in 1858, at Cornimont, Vosges, 50 horse-power was transmitted to a distance of 1258 yards; in 1859, at Oberursel, near Frankfort-on-the-Main, 100 horse-power was thus carried 1076 yards; and at Emmendingen, Brisgau, 60 horse-power works a spinning mill at 1312 yards from the motor; while in 1861, Count d'Espremesnil, at Fontaine le Sonet, Department de l'Eure, transmitted a very large power to saw mills through 1100 yards, and thence a part to a further distance of 546, or to a total of 1646 yards, to drive other machinery.

"*Four hundred and upwards* of practical applications have been made of the method already; which has become one of the estab-

lished and recognized mechanical appliances all through the south-east of France and adjacent Germany, and more particulary in Alsace, the great seat of the French cotton manufacture, and of innumerable connected industries.

"Most of the machinery has been constructed by Messrs. Stein & Co., of Mulhausen, who have acquired great experience in its constructive details and management. And, carrying the principle out to its legitimate end and developement, a company has been formed since 1862 at Bale, in Switzerland, under the title of "Compagnie d'Utilization des forces du Rhin Superieur," whose object it is to establish water power to an almost limitless extent at the great fall of the Rhine at Schaffhausen, and thence to transmit it off to great distances and in various directions, and let it off for manufacturing uses. Mr. Hirn has shown that power may be practically and profitably transmitted thus for distances of several miles. To take an extreme example, he proves that 120 horse-power may be transmitted 22,000 yards, or about 12½ miles, and that the loss by uselessly expended power in the transmission even to that extreme distance, shall leave, at the very least, 90 horse-power available at the remote end. On the other hand, he shows that if 200 horse-power be transmitted by ordinary horizontal shafting, fifty per cent. of the motor will become uselessly absorbed within a distance of 1650 yards, and that to obtain 100 horse-power at the remote end of a horizontal shaft 12½ miles long, we must apply at the motor end a power of 788,400 horse-power: in other words, that while the limit of shaft transmission practically does not exceed two or three hundred yards, that of telo-dynamic transmission need not, in practice, stop at five miles, or even more. Power may thus be transmitted economically and surely, in any direction, over hills and valleys, across rivers, into the depths of coal pits or mines."—*Practical Mech. Jour., March*, 1867, *p.* 358.

(To be continued.)

THE experiments which have been made over the telegraph lines between Harvard College and San Francisco, show that the traveling time required by electricity is as follows from Boston: To Buffalo and back, 0·10 seconds. To Chicago and back, 0·20 seconds. To Omaha and back, 0·33 seconds. To Salt Lake and back, 0·54 seconds. To Virginia City and back, 0·70 seconds. To San Francisco and back, 0·74 seconds.

THE DREDGING MACHINE.

By D. S. Howard, C. E.

No dredging machine is equally well calculated for all kinds of dredging, under various circumstances. Some underwater excavations are required to be continued through dry land, and the deposits made on the banks; at other places the height of the banks requires the excavated material to be put into lighters. As the lighters in such cases cannot be placed alongside at all times, the deposits must be made over the stern. Other work is situated in water sufficient on all sides to float the machine and lighters, which requires another modification of the machinery, in order that it may be economically adapted to the situation.

There are variations of the material also, in which no invariable machinery will work equally well. Wherefore I have generally heretofore constructed dredging machines expressly for particular works, without any view to the execution of any other work. But I have frequently found circumstances to vary the conditions of the same work so much, that two or more machines, very different in construction, were required to complete it with economy.

From these considerations, after long experience in constructing and working dredging machines of various descriptions, under a great variety of circumstances, I have prepared the following plans of a machine, which has been found capable of being adapted to a very large range of circumstances and situations.

Such a construction is more valuable, since the improvements made in the materials, the manufacture and the construction of the machinery render it so much more durable, that its usefulness is extended beyond the immediate purposes for which it was originally constructed.

Fig. 1 is a side view of a dredging machine calculated to deposit in lighters, over the stern or at the sides, as occasion may require. It is also calculated to work with any shaped bucket best adapted to the material to be excavated.

Fig. 2 is an end view of the same, showing the facilities for lateral deposit. The same letters refer to like parts in each.

A is the driving chain-wheel, geared to the engine by the wheels and shafting, shown in Figs. 1 and 2.

B designates the buckets attached to the chains shown in Figs. 1 and 2.

C represents the centre cylinders, with the spiral scrapers and hooks, for loosening and conveying the material to be excavated, from the centre, each way, to the buckets.

D, in Fig. 2, represent short cylinders on the ends of the cylinder shaft, E, Fig. 1, with spiral scrapers for conveying the material to be excavated, from the outside to the buckets.

The short cylinder on the port side of the dredge, Fig. 1, is left off, to show the lower chain-wheels and the lower attachments to the ways.

F is one of the lower chain-wheels, attached to the cylinders and driven by the chains, in the same manner as the chains are driven by the driving chain-wheel, A, by cams fitting into alternate links of the chain.

G is one of the flange-wheels seen in Fig. 1, over which the chain passes before descending to the lower chain-wheels, F.

H is one of the movable frames, which suspends the flange-wheels, G, on rollers running upon ascending ways, provided with powerful purchase-wheels, terminating in a pinion working in a descending rack, shown in Fig. 1.

This purchase is worked by a cog-wheel on the flange-wheel shaft (not shown in the drawing), working in a wallower-wheel, J, when thrown into gear, for the purpose of raising the buckets from the bottom when required, by forcing the flange-wheels, G, up the inclined ways. When the machine is not in motion, the wallower-wheel may be thrown out of gear, and worked by hand, with a long double crank, K, Fig. 2.

By the motion of the buckets in the direction of the arrows, the excavated material is brought up, and if it is to be deposited over the stern, it is dumped into the movable spout, L, Fig. 1, which is attached to the axis of the flange-wheel, G, by the extension of its sides, and moves freely within the stationary spout, M, allowing the flange-wheel, G, to be drawn up, when necessary, with the movable frame, H, without changing its proper position, for receiving the contents of the buckets as they pass over the flange-wheel, G.

N, Fig. 1, is the counter balance, situated about 25 feet aft of the hull, attached to it by a truss frame and hog chains, for the purpose of balancing the weight of machinery necessarily placed ahead of the hull, to enable the dredge to clear its own way. It is also

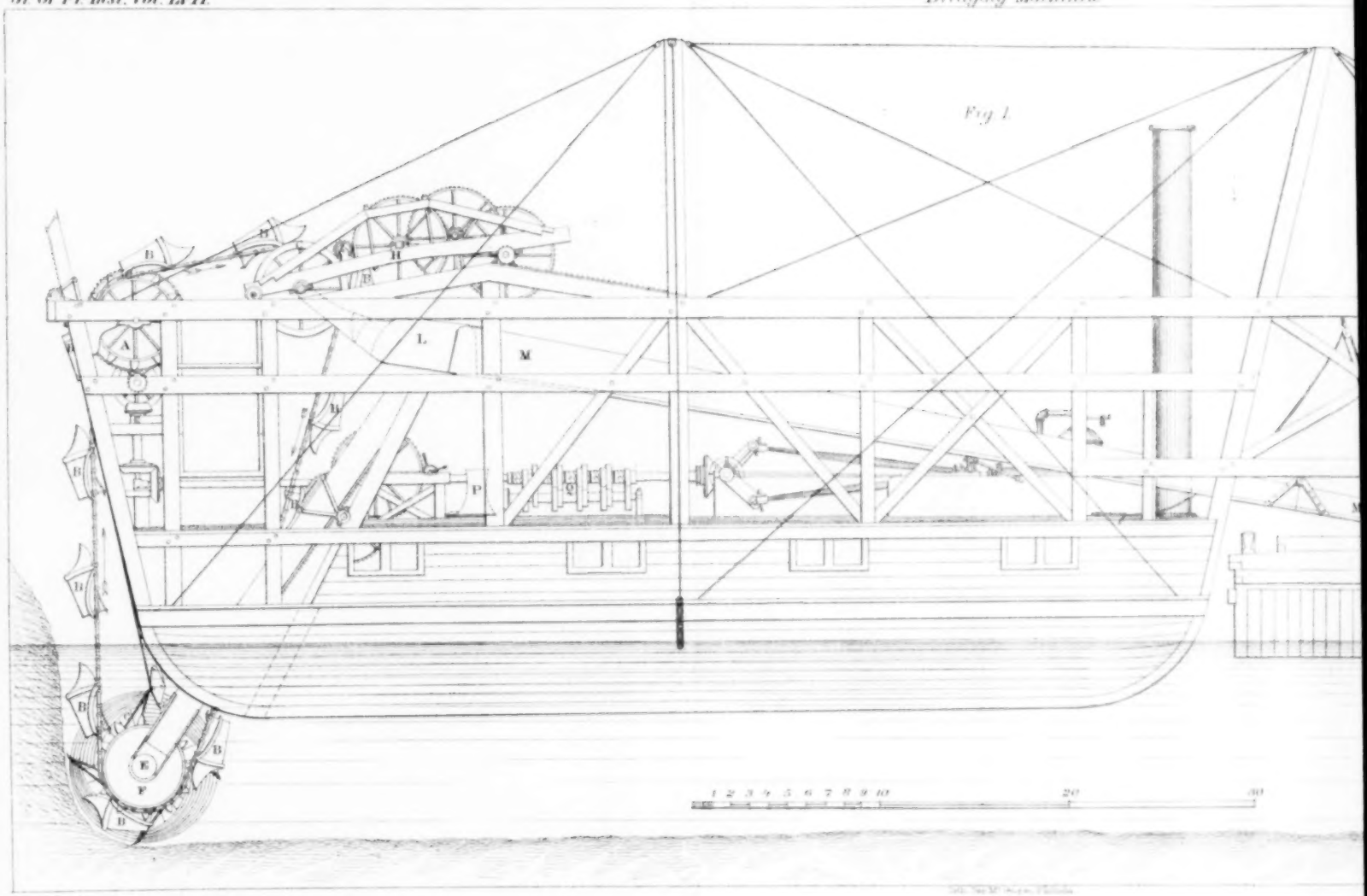
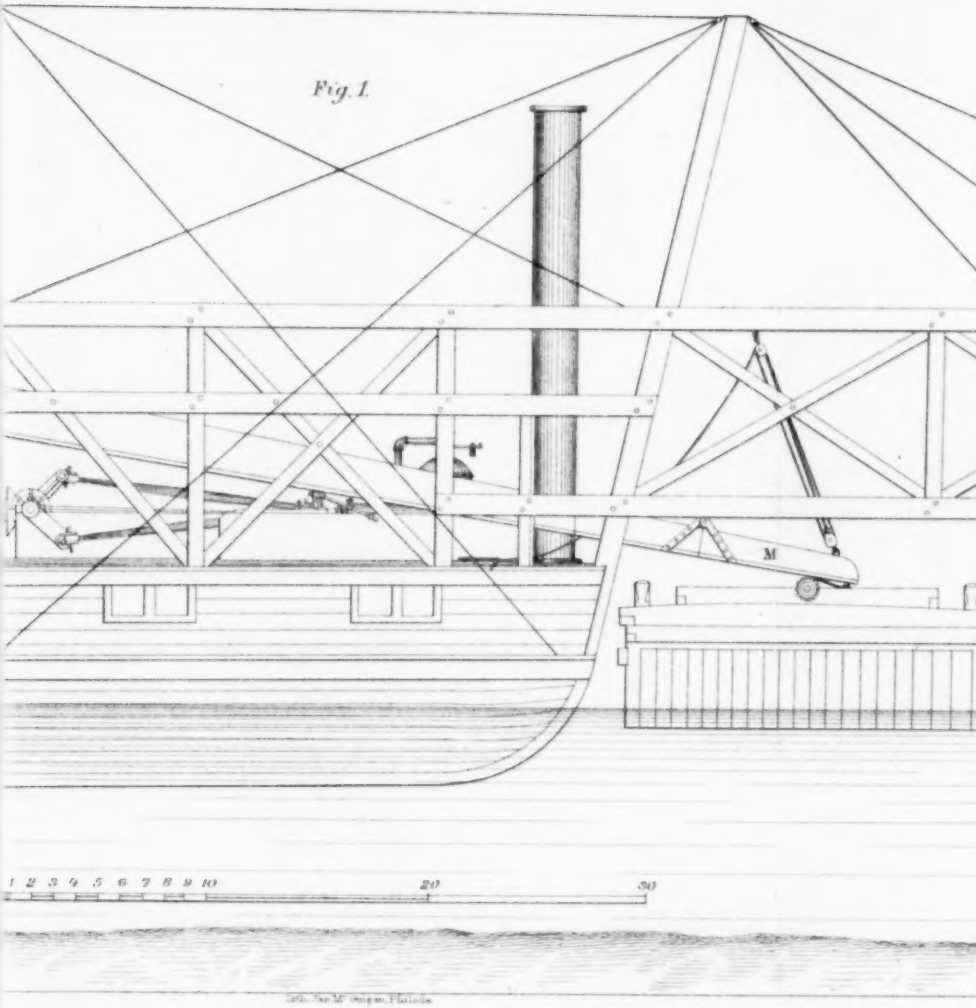


Fig 1.
A
B
C
D
E
F
G
H
L
M
P
1 2 3 4 5 6 7 8 9 10
20
30

Dredging Machines.

Fig. 1.



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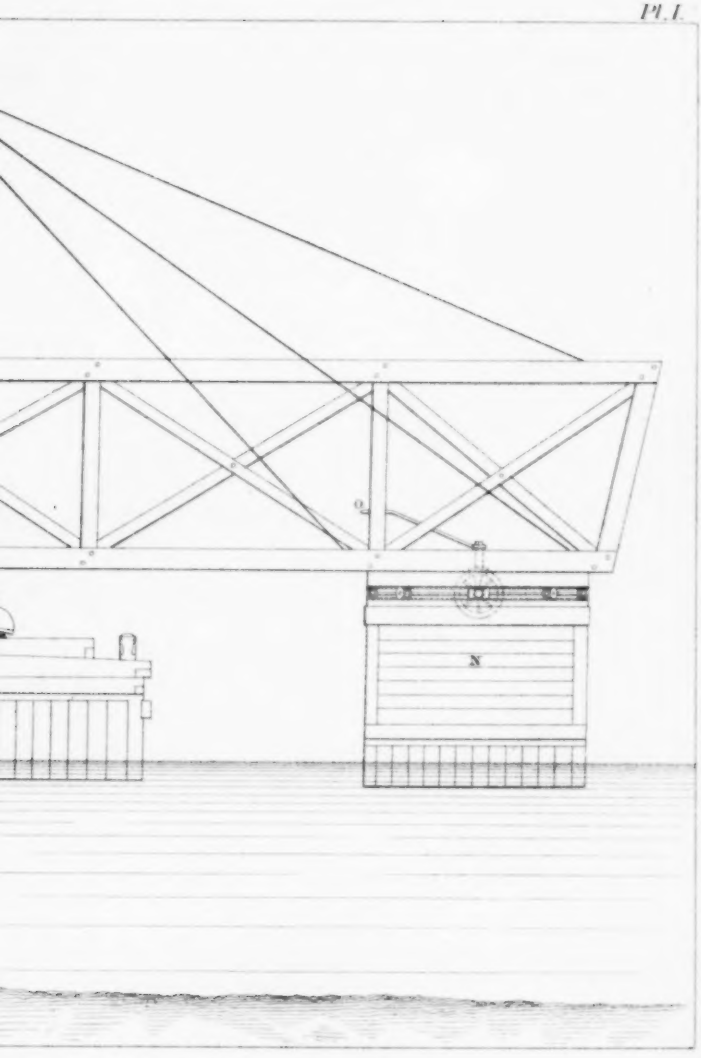

N

used for transferring the lighters, by attaching the empty one to the outside of the counter balance, and the loaded one to the inside; then by the lever, O, which works the geared rollers between the counter balance and the truss frame, the two lighters are changed about, the empty one inside, under the spout, M, ready to be filled, and the loaded one outside, ready to be transferred to the dumping place. It is also used as a water tank for the engine, which may be filled in the morning, before the water has been disturbed by the dredging, sufficiently to afford clean water during the day.

B, Fig. 3, is a perspective view of a bucket used in this arrangement for depositing over the stern. It is provided with a loose bottom, which drops with the load about two inches, rendering the discharge perfectly certain when at work in the worst kind of material.

When the situation of the work is such as to require the deposit to be made on the bank, or into the lighters alongside, a bucket like B, Fig. 4, is put on the chain, in place of B, Fig. 3, which dumps into the lateral spouts, situated between the driving chain-wheel, A, and the flange-wheel, G, by the tripping of the latch which lets fall the whole under side of the bucket, hinged to the bolt that fastens the bucket to the chain. This insures the discharge of the most difficult material.

The short receiving spouts under the buckets, and the one between them, are hung on pivots in the centre, so that either end may be elevated, and the contents of both sets of buckets discharged on either side, or both sides, as may be desired.

Whenever the extent of the work requiring a lateral deposit is sufficient, the hull of the dredge may be built long enough, and lean enough aft, to balance the machinery forward, without the counter balance.

When the work is situated in water deep enough in front of the dredge to float the loaded lighters, the buckets like B, Fig. 5, which dump through the bottom, are brought into requisition, the latch to these may be tripped anywhere on their perpendicular way up, and discharged into a short vibrating spout, which conveys the material directly into the lighter, placed much nearer than it can be in any other arrangement. Thus saving power in proportion to the height of discharge.

Fig. 6 is a gang of hooks, sometimes put upon the chains between the buckets, when working in hard, coarse material, like cobble-

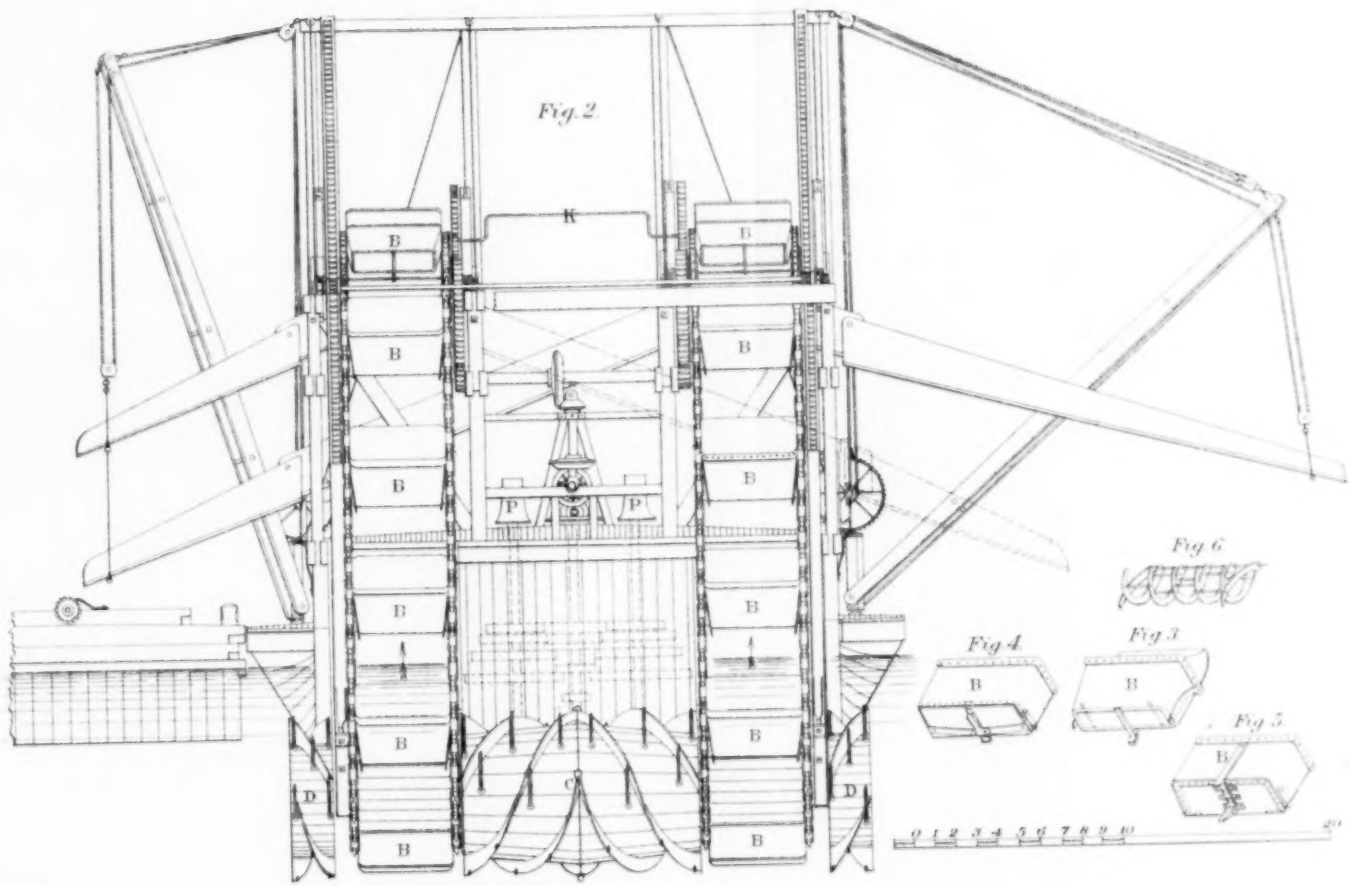
stone, shale, or hard-pan. The chain is so constructed that any shaped bucket, or any other device for loosening the material, that might be found in practice to be preferable, may be put upon it. All the articles here represented have been fully tested, and found very useful in their places. No sacrifice of power, or of economy in working, has been required to enable us to use all these appliances on the same machine; on the contrary, the perpendicular position of the working part of the chains, and their passing around three drums instead of two, are great improvements under all circumstances.

The perpendicular application of power secures a great economy of friction, in the wear of rollers, ways, &c., especially where no lubricating material can be used, nor the wearing parts secured from the destructive action of sand and water, which must always be present in dredging.

The third drum, which constitutes the flange-wheels, G, enables us to raise the buckets from the bottom, in the manner above mentioned, without changing the perpendicular position of the working part of the chain. It also furnishes the best possible position for the discharge of buckets like B, Fig. 3, at all times when that kind of bucket is in use. Also, that of B, Fig. 4, which dumps between the two upper drums, requiring nearly an horizontal position to discharge.

The bucket B, Fig. 5, is equally well accommodated. This one may be dumped anywhere on the perpendicular part of the chain, by raising or lowering the vibrating spout which trips the latch. This is the most economical of all the different buckets, where circumstance are favorable for its use, as it dumps with perfect freedom all kinds of material, and is discharged at a much less elevation, on account of its better relative position with respect to the lighters.

In working these machines, a pully is anchored at a convenient distance ahead, with a feed line passing from one of the feeding capstans, P, through the pully and back to the other capstan, either one of which, or both, may be worked by the adjustable machinery to any required motion, by a change in the series of clutches at Q, or a series of wheels below deck; while the spiral cylinders below water, with the buckets, clear the way to the full width of the dredge, and to the depth required, bringing up the material and depositing it in lighters, or on the banks, or at any distance in any direction horizontally, not exceeding one in twelve of the altitude



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overcome, by supporting a spout, lined with sheet iron, of the length required, on a movable support, that it may coincide with the feed motion of the dredge.

The distance from the dredge at which the deposit is required, determines the length and inclination of the spouts. Something, however, depends upon the nature of the material excavated. If it contain clay, or vegetable matter sufficient to prevent the water from draining out too soon, it will run on a descent of one inch to the foot, without more water than the buckets bring up with it; but if the material be pure sand or gravel, a pump will be required to assist in the discharge, without more inclination of the spout.

These machines can be constructed with any dimensions, to suit the magnitude of the work, provided the proper proportion of the parts be preserved for strength, motion, power, and durability. These considerations are very important for the success of any machinery, more particularly such as is supported on a floating foundation.

As yet, I have never been called upon to build a dredging machine that would excavate more than three thousand cubic yards in a day of ten hours, but one may be built, with economy, to raise double that amount, rather than build two for the same work, as only the same number of men are required on the dredge, all the additional help being that needed to dispose of the excavated material.

The Central American Transit Company, with William H. Webb as President, and J. E. Body, Vice-President, built one of these machines, on a small scale, in 1867, for the purpose of improving the San Juan river, in Nicaragua, and the harbor at its mouth. This was capable of raising three thousand cubic yards per day, and was worked with great satisfaction, until, by some misunderstanding between the Company and the Government of Nicaragua, the work was suspended.

Another machine, with some of the above improvements, was built in 1857, for the Corpus Christi Ship Channel Company, in Texas, with which the Channel was finished to sixty-four feet in width, without the use of a lighter, except to support the long spout in which was run off the excavated material, on an inclination of one inch to a foot.

Lyons Falls, N. Y., Dec., 1868.

EXTRACTS FROM AN ENGINEER'S NOTE BOOK.

By W. M. Henderson, Hydraulic Engineer.

(Continued from page 168).

Combustion as applied to Steam Boilers.

In a properly constructed steam-boiler, an average of ten pounds of coal will be burned per square foot of grate per hour with natural draught, and as one pound of good coal will evaporate about eight pounds of water, eighty pounds or about ten gallons of water will be evaporated for each square foot of grate surface per hour. When blast is employed, these quantities may be doubled. The furnace room should be from 1·5 to 2·5 cubic feet per square foot of grate, according to the consumption of coal. The boiler room should be about one cubic foot for each square foot of heating surface. The area of heating surface should not be less than one square foot per pound of coal consumed per hour, or, where it can be obtained, as 18 to 1. of the grate surface. Area over bridge, through flues and chimney, two square inches per pound of coal consumed; or, taking twelve pounds of coal as being the maximum that can be burnt upon a square foot of grate, a calorimeter of twenty-four square inches per square foot of grate surface is recommended for natural draught. Ash-pit entrance for air, one-half area of grate. Area of orifices for admission of air above grate should be about four square inches for each square foot of grate, more or less, according to the gas-generative qualities of the coal and extent of combustion. In regard to the disposition of the heating surface, it should be as concentrated as possible, as experiments have shown that the first foot of the length of tubes in horizontal boilers, next the furnace, was equal in evaporative value to the furnace itself; that the next four feet were not equal to the first foot, and that the fifth foot possessed very feeble generative properties. It is therefore considered there is no gain in having tubes in such boilers over six feet in length, and that the effective length of flues in horizontal boilers is arrived at within very moderate limits, probably not exceeding the maximum of twenty feet. The reason of this is quite obvious, as a boiler may be of such length that the generative value of the heated gases may be entirely expended before they have reached the extreme end, in

which event, it is plain, a positive loss is entailed; for the water which has been heated at the furnace end, and the steam which has been raised there, must be deprived of a portion of that heat again, in order to raise equally the temperature of the water at the cold end.

For many years, within the experience of the writer, it was the practice to construct steam-boilers from 40 to 60 feet in length, with a view to use up the whole of the heat resulting from combustion of the fuel. Some of those very boilers, after being cut in two—the one-half only retained—gave such improved results as to have at last completely exploded that plausible theory. Quite an important feature in the generation of steam is to be found in the manner of conducting and applying the heated gases to a steam boiler. They should be led at once through the body of the water, *i. e.*, through flues or tubes, and if a return can be made, with a view to economy, to make such return under the shell, and if practicable, with a still further view to economy, over the shell of the boiler. No doubt much of the merit pertaining to the Cornish type is due to this manner of construction. Of the double-flue description, the Butterley, or Fish-mouth, or, as it is better known in this country by the more modern name of the Corliss boiler, is far preferable to the common flue boiler, where the heat passes backwards, first under the boilers and lastly through the flues, passing the most effective heating surfaces at the time it has no real generative value. Another matter of eminent importance to this subject, and one which has not received that degree of attention its worth demands, is that of supplying to the uninflamed gases of the furnace the necessary amount of oxyen to insure perfect combustion, which otherwise would escape unconsumed into the atmosphere. This is the only method of obtaining from the fuel the maximum of heat it is capable of yielding. By experiment it has been shown that the saving effected in coal, by a judicious attention to this particular, has been from 12½ to 33 per cent., accompanied with a perfect freedom from smoke, as all smoke consists of a portion of the carbon of the fuel passing off unconsumed.

It is believed this discovery, like many others of great merit, was the result of mere accident, not being brought about from any hope of economy, but the desire to suppress the intolerable nuisance of smoke, emitted from the furnaces in the manufacturing districts of England, from the combustion of bituminous coal. In the com-

bustion of anthracites, as largely employed in this country, no great objection has been found to the comparatively colorless smoke emitted, and so it has been allowed to pass unheeded; but as anthracites contain more carbon than bituminous coals (as high as 90 per cent.), even more air is required for their combustion than the latter description; and unless this air is supplied, large quantities of carbonic oxide will be constantly discharged into the atmosphere, carrying off a large per centage of the carbon of the fuel, without contributing in a proper manner to the generation of steam. As regards the form of the furnace, many curious ideas exist. It has been contended that the crown sheet should be low enough, so that the flame may impinge with *force* upon it. The value of position of the heating surfaces have been settled for us, by some authority, long ago, and has been religiously copied in all our works of modern compilers, who inform us that only horizontal surfaces should be considered, and calculated, as direct heating surface; that vertical sheets must only be taken at half value, and that the upper half of the circumference of flues alone are effective. Now, caloric being a body which radiates in all directions, the transmission of heat through the different parts of a steam-boiler cannot vary to such an extent as the above calculations lead us to believe. It is true the heated gases have a tendency to rise to the highest points, but where the calorimeter is properly calculated to carry away the net products of combustion, it cannot ascend in this manner, and must tend to diffuse itself over every avenue, in order to effect an exit. A large firebox or capacious furnace is necessary to produce a thorough admixture of the gases of combustion, which undoubtedly should take place in that part, where the necessary heat is present to insure this result. The concentrated action of the heated currents upon the fire box must be more injurious with a low-crown sheet than a high one; in either case it would be bad enough, were it not for the great difference which exists between the temperature of the box and the water within the boiler, which seldom or never exceeds 400°, whereas that of the furnace may proably reach as high as from 1500° to 2000°.

The absorbent material should be as thin as possible, therefore of the highest standard of quality, in order to save time in the transmission of heat, and to effect a rapid evaporation of the water contained within the boiler. As regards the effective evaporating results, or transmission of heat through metals, this depends upon the

three following properties: 1st, the resistance of the surface next the fire to absorption of the heat; 2d, the resistance of the internal particles of the metal to the conduction of heat; and 3d, the resistance of the surface next the water in giving off the heat. The relative evaporating power of wrought iron, brass and copper are, respectively: 100, 125, and 156.

(To be continued.)

LOCATION OF INDEPENDENT STEAM FIRE AND BILGE PUMPS IN STEAMERS.

By Chas. H. Haswell, C. E.

Read before the Institution of Naval Architects, London, March 19, 1869.

Of all the instruments and appendages connected with a marine steam engine and the provident fitting of a steamer, the Independent Steam Pump, or Donkey, as it is termed, stands pre-eminent in importance; both on account of its general utility and its being under many very probable and oft occurring circumstances indisputable to the safety of a vessel.

The application of this instrument extends from the ordinary operations of a bilge pump and a boiler feed pump to those of a fire and a hold discharge pump.

When, therefore, the extended and in many cases, the indispensable operations of this instrument are duly considered, it would seem to be imperative that it should be located where it can be most readily reached, and where it can be operated for the longest period without being submerged by water, enveloped in smoke, or cut off by fire.

It occurs, however, that as a rule of British and European practice, that it is located in the hold of steamers, immediately upon the lower engine-room floor; this practice, taken in connection with the insufficient capacity of the pump for the general purposes of fire and leaks, would seem to have arisen from the functions of the pump, as viewed by the constructors of the engines, being restricted solely to the operation of feeding and pumping out boilers.

The cases in which the location of the pump in the manner referred to, are objectionable, are as follows:

1st. A leak occurring in the furnace or water-bottom of a boiler,

and the hot vapor arising therefrom precluding access to the pump and the setting of it in operation; whereby the water escaping from the boiler, not being replaced by the operation of this pump, would soon expose the tubes or crown-plates of the furnace to be burned, and the boiler thereby rendered unsafe for operation.

2d. A leak in the hull of a steamer suddenly occurring from a collision with ice, another vessel, a pier or sunken rock, or the disruption of the propeller-shaft stuffing box in a propeller, whereby the influx of water would be fully equal to the combined capacities of the pump and engines to discharge. The distance between the pump and the floor of the vessel or the level of the water in the hold, would be so little, that any arrest of the pump from continuous operation for adjustment or repair, would involve its submersion before it could be set in reversed operation.

3d. A fire occurring on the main deck of a steamer, whereby the smoke would be drawn into the engine and fire-rooms by the draught of the furnaces of the boilers, and this pump rendered inutile by the impracticability of reaching it to set it in operation.

4th. A vessel grounded or stranded upon a sand or soft bottom and leaking; her pump from the ingress of sand and mud into her hold, would require frequent clearance, the delay consequent upon which would cause the pump to be submerged before it could be freed and set in operation.

The only defence that ever has been advanced for this violation of regard to the safety of a vessel, in locating this pump where in many cases, as is here shown, it would necessarily be inoperative, is, that in the event of the hold being flooded with water, that the fires in the furnaces of a boiler would consequently be drowned, and that the steam wherewith to operate this pump being obtained from the boilers, that its functions would cease with the drowning of the fires.

Admitting this position to be strictly tenable, it does not meet the conditions of this pump being arrested in its operations by sand, mud, smoke, or the escape of steam. The position advanced, however, is not one of general application, as in a majority of cases, and especially in this country, there is an independent boiler connected with this pump, which when located upon the main or span deck, and acting independently of the engine boiler, its functions would not be affected by the influx of water into the hold of a vessel.

The common plea, that a pump located in the hold of a steamer, below the water line, will operate more effectively than if located upon the main deck, is only advanced by some engine drivers, whose conceptions of a steamer are restricted to the operations of the engines and their dependencies, or by some owners of steamers, who are disinclined to incur the cost of a removal of the pump to a proper location.

In this connection, the capacity of this pump proportionate to the dimensions of the vessel, is worthy of consideration, and as a further rule of practice, the capacity of this pump in British and European steamers is much inferior to that in use in this country.

The general security of lines in British vessels, under the stringent orders and requirements of Lloyd's rules, has not generally opened the subject of the propriety of using a steam pump for other purposes than those referred to, as confined to the operation of the boilers of a vessel; for in many cases, this pump cannot be used to draw water from the bilge or hold of a vessel, and has not any fire hose connections beyond the immediate precincts of the engine-room.

The capacity of this pump, proportionate to the vessel in this country, may be judged of from the following cases:—

A British steamer, now in this port, built upon the Clyde as late as 1867, and belonging to a leading company in the extent and character of its trade, presents the following cases:—

$$\frac{l - \frac{3b}{5} \times b \frac{b}{2}}{95} = 3{,}230$$ tons, has but one independent pump, having a water cylinder of one gallon, or a discharging capacity of 12,000 gallons per hour, or 3·7 gallons per ton per hour.

The new steamers of the Pacific Mail Steamship Company, built in this city in 1867, present the following case:—

$$\frac{l - \frac{3b}{5} \times b \frac{b}{2}}{95} = 4{,}200$$ tons have four independent pumps, having water cylinders of 11·4 gallons capacity, or a discharging capacity of 136,500 gallons per hour, or 32·5 gallons per ton per hour.

In further support of the position assumed, I submit that there has occurred very many cases where steamers have foundered, burned, or been wrecked in consequence of the location of their independent steam pumps in their holds. Three cases, and import-

ant ones, so far as the loss of lives and property are concerned, can but be familiar to all.

The Arctic, foundered at sea, 1854, had two independent pumps of a combined discharging capacity of 31,000 gallons per hour, and an attached boiler, all of which were located in her hold. When her bottom was perforated by collision with the sharp prow of an iron steamer, the influx of water was superior to the capacity to discharge it, and for the following causes:—

1st. Her independent boiler could not be put in operation until steam was raised in it.

2d. Her floor being filled in solid, her bilge injections could not operate effectually, until the water was fully two feet in depth, in consequence of the roll of the vessel.

3d. At the time sufficient water had flowed into the hold for the bilge injections to operate with their full capacity, the additional depression of the vessel, occasioned by the influx of water, had reduced the number of revolutions of the engines, and consequently their capacity to discharge the inflowing water; added to which, the water at that height washed the water bottoms and ash pits of the boilers, and reduced their capacity to furnish steam to operate the engine.

Thus, with a constant flow of water, the capacity to discharge it was being rapidly lost.

It occurred however, that there elapsed a period of four hours after the collision before the vessel sunk, and as a computation made by me of her entire weight as a mass, less the actual displacement of every particle of her and her cargo, gave but a difference of 1,000 (one thousand) tons, it appears that the discharge of this weight of water, or 65,570 gallons per hour, would have kept this vessel free of water, and enabled her so far as that collision was concerned, to have reached a port of safety.

Now, as the capacity of her bilge injections at even the reduced number of revolutions of ten would have been equal to 80,000 gallons water per hour, it is manifest that the loss of this vessel at this time, is directly attributable to the location of her independent pumps and their attached boiler.

The Austria, burned at sea, in 1858, in consequence of the smoke from a fire upon her main deck pervading the engine-room, suffocating the watch, and as a consequence precluding the operation of her pump as a fire-engine.

The Britannia, lately foundered at sea, by the flow of water in her engine-room, and the submerging of her independent pump.

The remedy I propose for this objectionable manner of the filling of a steamer, is to require this pump to be located upon the main or tonnage deck, and that it have an independent boiler attached to it, located upon the main deck, or, preferably, upon the upper deck, and that all passenger steamers be required to have the boiler ready for operation during the night, or during the prevalence of a fog.

Ejector Condenser.—We see in several of the English journals, accounts of a new piece of apparatus devised by Mr. Alexander Morton, of Glasgow, which, on the principle of the Giffard Injector, is intended to maintain the vacuum of a condensing engine by the escaping velocity of the residual steam on the exhaust side of the piston. We do not attempt to reproduce any of the drawings which have been published because they are all evidently fancy sketches, and of very bad proportion, so that a better idea can, we believe, be conveyed by a simple description. The apparatus consists of a series of concentric nozzles, arranged somewhat as in the simpler forms of the Giffard Injector, where no provision is made for adjustment. First of all comes a small central steam nozzle connected directly with the boiler, this is surrounded by a water jet, and is employed to start the flow where a head of water is not attainable, then follow two steam nozzles connected with the exhaust parts for either end of the cylinder.

Lastly, a trumpet-shaped outlet tube like the induction nozzle of the Giffard. The water being once started the condensation of the steam in the nozzles will give sufficient velocity to the outflow to keep up a good vacuum, even removing large quantities of air from the cylinder.

Prof. Rankine has prepared a thorough discussion of the theory, and tabulated the result of many experiments made with this instrument. There is one feature of doubt appearing in these experiments, however. The amount of heat in the escaping water is largely in excess of that due to the steam doing work in the cylinder. If this represents live steam, used direct from the boiler through the first nozzle to effect the action of the apparatus, the economy of the instrument disappears.

Mechanics, Physics, and Chemistry.

ANALYSIS OF HOT CAST PORCELAIN WITH SOME REMARKS ON ITS COMPOSITION.

By Chas. P. Williams.

(Late Prof. Analytical Chemistry, Polytechnic College.)

"Hot Cast Porcelain" is the trade-name of a peculiar, tough, milk-white, translucent glass, not unlike French porcelain in appearance, now extensively manufactured in Philadelphia and Pittsburg. It is intermediate in character with the glasses produced by the addition of phosphate of lime to the ordinary glass materials, on the one hand, and the white enamels, such as are produced by oxide of tin, on the other, having more of the milkiness than the former, and less opacity than the latter.

The raw materials consumed in its production are sand, oxide of zinc and cryolite (native double fluoride of aluminium and sodium) which are melted together in the ordinary clay pots of the glass maker. After complete fluxing, and when in a state of quiescent fusion, the material or "metal" is capable of all the manipulations of the ordinary glasses.

The following is the composition of an average sample of this glass, taken when the "metal" was in its best working condition: Silicic acid, 63·84; alumina, 7·86; sesquioxide iron, 1·50; protoxide manganese, 1·12; oxide zinc, 6·99; lime, 1·86; magnesia, 0·25; soda, 10·51; fluorine, 8·05; [less oxygen (corresponding to the fluorine) 3·39] = 98·59. The above is the mean of five analyses by myself; two analyses by Mr. Wm. Main, Jr., in my laboratory give a mean agreeing very closely with that given above.

The method pursued in the above analyses consisted in fusing the compound with carbonate of soda, extracting with water, and, after precipitating the silica and alumina in the aqueous solution by means of carbonate ammonia, separating the fluorine as fluoride calcium, mixed with carbonate of lime, by the addition of chloride of calcium. The mixed salts were afterwards treated with acetic acid, and the separated fluoride of calcium, dried, burned and weighed. The remainder of the analyses was conducted as is usual in the analysis of silicates, the alumina and oxide of iron being precipitated as basic acetates and separated, after weighing, by means of

tartaric acid and sulphide ammonium; the oxide of manganese precipitate as binoxide in the acetic acid solution, by means of bromine;* the zinc precipitated as a sulphide by sulphydric acid in presence of acetic acid, and weighed either as a sulphide (by ignition with sulphur in a current of hydrogen gas) or as an oxide; the lime thrown down as an oxalate and weighed as caustic lime, and the magnesia precipitated by phosphate soda. Separate portions were taken for the alkali determinations and treated with fluohydric acid in the usual way.

Admitting the fluorine to exist in the glass in the condition of the silico-fluoride of sodium (Na F SiF_2), the following will express the composition of the compound:

	Per cent.				
Silicic acid	59·59	Oxygen		31·78	
Alumina	7·86	"	3·66	4·11—R_2O_3	
Sesquioxide iron	1·59	"	·45		
Protoxide mang.	1·12	"	·25	3·85—RO	
Oxide zinc	6·99	"	1·38		
Lime	1·86	"	·53		
Magnesia	·25	"	·10		
Soda	6·18	"	1·59		
Sodium	3·25				
Silicon	1·98	= 13·28 per cent. Silico-fluoride sodium.			
Fluorine	8·05				
	98·66				

Which agrees very closely with the formula—

$$2\left(R_2O_3\,3\,SiO_2 + 3\,(R\,O\,3\,SiO_2)\right) + NaF\,SiF_2.$$

The protoxide of manganese results from the addition of binoxide to the materials for the purpose of destroying the color from the iron in the sand, etc. The total amount of soda (10·51 per cent.) corresponds to 23·84 per cent. of cryolite in the original mixture, which would contain 12·92 of fluorine, showing, therefore, that 4·87, or about 39 per cent. of the whole amount of fluorine is eliminated, by the melting operation in the form of fluoride silicon (SiF_2), requiring for its formation 3·85 per cent. additional of silica.

These figures would give as the approximate composition of one

* I have found the substitution of bromine for chlorine in the precipitation and separation of manganese to give very satisfactory results. It is particularly adapted for small amounts of manganese as in the ordinary run of iron ores, especially if the iron and alumina have been separated as basic acetates.

hundred parts of the original mixture when introduced into the melting pots, 67·19 parts of silica, 23·84 of cryolite and 8·97 of oxide of zinc. This, I believe, does not materially differ from the formula used in the practical operations at the factories in Kensington and West Philadelphia.

The rationale of the process appears to consist in the formation of a silico-fluoride of sodium from a part of the fluorine and sodium of the cryolite, the remainder of the fluorine uniting with silicon for the production of fluoride of silicon in which form it escapes from the pot. The remaining silica, uniting with oxide of zinc, the soda and alumina, resulting in the formation of a compound silicate not differing essentially (except in the substitution of oxide of zinc for lime or some other base commonly employed in glass manufacture) from some of the varieties of glass. Throughout this glass the fused silico-fluoride is distributed, acting in the same manner, though differing in the degree of its effect, as the phosphate of lime, so long employed for the production of milky glasses, for it has been shown by Brezelius that the alkaline-fluorides, in presence of silica, fuse at a bright red heat, without the evolution of fluoride of silicon, and pass, on cooling, into porcelain-like masses,* in the same manner as does the bone phosphate of lime.†

Besides the beautiful white glass produced in this manner, an additional benefit is derived by the employment of cryolite, from the fact that this mineral furnishes to the manufacturer of glass a comparatively cheap source of soda, dispensing with all the manipulations necessary to the production of soda ash either from cryolite or from common salt.

I am informed by W. J. Cheyney, Esq., of Philadelphia, the patentee of this new article of glass, that an article corresponding essentially in properties with "Hot Cast Porcelain," can be produced by the substitution of fluor-spar (fluoride of calcium) for cryolite. The milkiness in this case may probably be due to the formation of a corresponding silico-fluoride of calcium. I have verified this statement by melting together a mixture of feldspar, sand, fluor-spar and soda-ash, obtaining a product much resembling the genuine article. I have not yet been able to complete an analysis of this product.

* Gmelin's Chemistry, vol. iii., page 374, English edition.

† Ib. Page 192. According to Saussuer, the fusion takes place at 378° Wedgewood.

The "Hot Cast Porcelain" is capable of being colored by the metallic oxides usually employed in the manufacture of colored glasses, but the beautiful white of the body of the material heightens greatly the effect of these coloring matters. Both the white and the colored materials now find extensive employment in the manufacture of druggists' and perfumers' wares, pedestals for oil lamps, lamp shades, table ware and flooring tile. The patterns for this last are chaste, and the effect exceedingly pleasing. I am informed that in point of durability they are superior to the imported encaustic tiles.

It may be well to state that the action on the pots of the materials used in the manufacture of this glass, is no greater than obtains in the production of the other glasses. The pots used in Philadelphia are made from a mixture of German and Missouri clays, tempered with the baked material from old, broken pots.

Philadelphia, March 13th, 1869.

FORMATION OF AN ARTIFICIAL SPECTRUM WITH A FRAUNHOFER LINE.

By A. Wallner.

If, by means of a Holtz machine, at a short distance, the rapid discharges of a Leyden jar of about 30 square centimes are passed into an ordinary Geissler tube, and if the tube is placed before the slit of a spectroscope, the spectrum of the gas which fills the tube is first seen. If the length of the discharge is increased a little, the sodium line immediately appears as in the case of induction currents, by heating the capillary part of the tube placed before the slit. With a proper length of spark the brilliancy of the sodium line far exceeds that of the spectrum of the gas. By further increasing the distance of the discharge, the calcium line is produced with such intensity that it cannot be seen to greater advantage by any way hitherto known. Finally, if the length of the spark is again augmented, the phenomenon changes, the light in the tube assumes a dazzling splendor, this luminous line forms a continuous brilliant spectrum in which the spectroscope reveals a completely black line instead of the sodium line; this, therefore, is a Fraunhofer line. If the tube is attentively examined after this experi-

ment, one can connect the phenomenon with the explanation which M. Kirchhoff has given of the spectrum rays. The inner surface of the capillary tube is thickly corroded in consequence of the particles of glass taken away by each discharge, so that by prolonging the experiment, the glass may be completely roughened. These particles immediately raised to incandescence by the discharge, give the sodium line; but soon the tube is filled with sodium vapors, which then absorb the light proceeding from the solid incandescent particles; these form a kind of solid incandescent nucleus surrounded by an atmosphere of vapor.—*Ann. de Pogg.*, CXXXV.

ON THE RELATION OF HYDROGEN TO PALLADIUM.

By Thomas Graham, F. R. S.

(Master of the Mint.)

It has often been mentioned on chemical grounds that hydrogen gas is the vapor of a highly volatile metal. The idea forces itself upon the mind that palladium, with its occluded hydrogen is simply an alloy of this volatile metal in which the volatility of the one element is restrained by its union with the other, and which owes its metallic aspect equally to both constituents. How far such a view is borne out by the properties of the compound substance in question will appear by the following examination of the properties of what, assuming its metallic character, would fairly be named hydrogenium.

Density.—The density of palladium when charged with 800 or 900 times its volume of hydrogen gas is perceptibly lowered, but the change cannot be measured accurately by the ordinary method of immersion in water, owing to a continuous evolution of minute hydrogen bubbles which appears to be determined by contact with the liquid. However, the linear dimensions of the charged palladium are altered so considerably that the difference admits of easy measurement, and furnishes the required density by calculation. Palladium in the form of wire is readily charged with hydrogen by evolving that gas upon the surface of the metal in a galvanometer containing dilute sulphuric acid, as usual.* The length of the wire before and after a discharge is found by stretching it on both occa-

* *Proceedings of the Royal Society*, p. 422, 1868.

sions by the same moderate weight, such as will not produce permanent distension, over the surface of a flat graduated measure. The measure was graduated to hundredths of an inch, and by means of a vernier, the divisions could be read to thousandths. The distance between to fine cross lines marked upon the surface of the wire near each of its extremities was observed.

Experiment 1.—The wire had been drawn from welded palladium, and was hard and elastic. The diameter of the wire was 0·462 millimetre; its specific gravity was 12·38, as determined with care. The wire was twisted into a loop at each end, and the mark made near each loop. The loops were varnished so as to limit absorption of gas by the wire to the measured length between the two marks. To straighten the wire, one loop was fixed, and the other connected with a string passing over a pulley and loaded with 1·5 kilogramme, a weight sufficient to straighten the wire without occasioning any undue strain. The wire was charged with hydrogen by making it the negative electrode of a small Bunsen battery consisting of two cells, each of half a litre in capacity. The positive electrode was a thick platinum wire placed side by side with the palladium wire, and extending the whole length of the latter, within a tall jar filled with dilute sulphuric acid. The palladium wire had, in consequence, hydrogen carried to its surface for a period of one and a half hour. A longer exposure was found not to add sensibly to the charge of hydrogen acquired by the wire. The wire was again measured and the increase in length noted. Finally the wire, being dried with a cloth, was divided at the marks, and the charged portion heated in a long narrow glass tube kept vacuous by a Sprengel aspirator. The whole occluded hydrogen was thus collected and measured; its volume is reduced by calculation to Bar. 760 m.m., and Therm. 0° C.

The original length of the palladium wire exposed was 609·144 m.m. (23·982 inches), and its weight 1·6832 grm. The wire received a charge of hydrogen amounting to 936 times its volume, measuring 128 c.c., and therefore weighing 0·01147 grm. When the gas was ultimately expelled, the loss as ascertained by direct weighing was 0·01164 grm. The charged wire measured 618·923 m.m., showing an increase in length of 9·779 m.m. (0·385 inch). The increase in linear dimensions is from 100 to 101·605; and in cubic capacity, assuming the expansion to be equal in all directions, from 100 to 103·908. Supposing the two metals united without

any change of volume, the alloy may therefore be said to be composed of—

	By volume.		
Palladium	100·	or	95·32
Hydrogenium	4·908	or	4·68
	104·908		100·

The expansion which the palladium undergoes appears enormous if viewed as a change of bulk in the metal only, due to any conceivable physical force, amounting as it does to sixteen times the dilatation of palladium when heated from 0° to 100° C. The density of the charged wire is reduced by calculation from 12·3 to 11·79. Again, as 100 is to 4·91, so the volume of the palladium, 0·1358 c.c. is to the volume of hydrogenium 0·006714 c.c. Finally, dividing the weight of hydrogenium, 0·01147 grm. by its volume in the alloy 0·006714 c.c. we find—

Density of Hydrogenium	1·708

The density of hydrogenium, then, appears to approach that of magnesium, 1·743, by this first experiment.

Further, the expulsion of hydrogen from the wire, however caused, is attended with an extraordinary contraction of the latter. On expelling the hydrogen by a moderate heat, the wire not only receded to its original length, but fell as much below that zero as it had previously risen above it. The palladium wire first measuring 609·144 m. m., and which increased 9·77 m. m., was ultimately reduced to 599·444 m. m., and contracted 9·7 m. m. The wire is permanently shortened. The density of the palladium did not increase, but fell slightly at the same time, namely, from 12·36 to 12·12; proving that this contraction of the wire is in length only. The result is the converse of extension by wire-drawing. The retraction of the wire is possibly due to an effect of wire-drawing in leaving the particles of metal in a state of unequal tension, a tension which is excessive in the direction of the length of the wire. The metallic particles would seem to become mobile, and to right themselves in proportion as the hydrogen escapes; and the wire contracts in length, expanding, as appears by its final density, in other directions at the same time.

A wire so charged with hydrogen, if rubbed with the powder of magnesia (to make the flame luminous), burns like a waxed thread when ignited in the flame of a lamp.

Experiment 2.—Another portion of the same palladium wire was charged with hydrogen in a similar manner. The results observed were as follows:—

Length of Palladium wire	488·976 m. m.
The same with 867·15 volumes of occluded gas.	495·656 "
Linear elongation	5·68 "
Linear elongation on 100	1·3663 "
Cubic expansion on 100	4·154 "
Weight of palladium wire	1·0667 grm.
Volume of palladium wire	0·08072 c. c.
Volume of occluded hydrogen gas	75·2 "
Weight of same	0·00684 grm.
Volume of Hydrogenium	0·003601 c.c.

From these results is calculated:—

Density of hydrogenium	1·898

Experiment 3.—The palladium wire was new, and on this occasion was well annealed before being charged with hydrogen. The wire was exposed at the negative for two hours, when it had ceased to elongate.

Length of palladium wire	556·185 m. m.
Same with 888·303 volumes hydrogen	563·632 "
Linear elongation	7·467 "
Linear elongation on 100	1·324 "
Cubic expansion on 100	4·025 "
Weight of palladium wire	1·1675 grm.
Volume of palladium wire	0·0949 c. c.
Volume of occluded hydrogen gas	84·3 "
Weight of same	0·007553 grm.
Volume of hydrogenium	0·003820 c. c.

These results give by calculation:—

Density of hydrogenium	1·977

It was necessary to assume in this discussion that the two metals do not contract or expand, but remain of their proper volume on uniting. Dr. Matthiessen has shown that in the formation of alloys generally the metals retain approximately their original densities.*

In the first experiment already described, probably the maximum absorption of gas by wire, amounting to 935·67 volumes is attained. The palladium may be charged with any smaller proportion of hydrogen by shortening the time of exposure to the gas (329 volumes

* *Philosophical Transactions*, 1860, p. 177.

of hydrogen were taken up in twenty minutes), and an opportunity be gained of observing if the density of the hydrogenium remains constant, or if it varies with the proportion in which hydrogen enters the alloy. In the following statement, which includes the three experiments already reported, the essential points only are produced:—

TABLE.

Volumes of Hydrogen occluded.	Linear expansion in millimetres.		Density of Hydrogenium.
	From	To	
329	496·189	498·552	2·055
462	493·040	496·520	1·930
487	370·358	373·126	1·927
745	305·538	511·303	1·917
867	488·976	495·656	1·898
888	556·185	563·652	1·977
936	609·144	618·923	1·708

If the first and last experiments only are compared it would appear that the hydrogenium becomes sensibly denser when the proportion of it is small, ranging from 1·708 to 2·055. But the last experiment of the table is perhaps exceptional, and all the others indicate considerable uniformity of density. The mean density of hydrogenium, according to the whole experiments, excluding the last referred to, is 1·951, or nearly 2. This uniformity is in favor of the method followed for estimating the density of hydrogenium.

On charging and discharging portions of the same palladium wire repeatedly, the curious retraction was found to continue, and seemed to be interminable. The following expansions, caused by variable charges of hydrogen, were followed on expelling the hydrogen by the retractions mentioned:—

	Elongation.		Retraction.	
1st experiment	9·77	m. m.	9·70	m. m.
2d "	5·765	"	6·20	"
3d "	2·36	"	3·14	"
4th "	3·482	"	4·95	"
			23·99	

The palladium wire, which originally measured 609·134 m. m.,

has suffered by four successive discharges of hydrogen from it, a permanent contraction of 23·99 m. m.; that is, a reduction of 5·9 per cent. in its original length. The contractions will be observed to exceed in amount the preceding elongations produced by the hydrogen, particularly when the charge of the latter is less considerable. With another portion of wire the contraction was carried to 15 per cent. of its length by the effect of repeated discharges. The specific gravity of the contracted wire was 12·12, no general condensation of the metal having taken place. The wire shrinks in length only.

In the preceding experiments the hydrogen was expelled by exposing the palladium placed within a glass tube to a moderate heat short of redness, and exhausting by means of a Sprengel tube; but the gas was also withdrawn in another way—viz., by making the wire the positive electrode, and thereby evolving oxygen upon its surface. In such circumstances, a slight film of oxide of palladium is formed on the wire, but it appears not to interfere with the extraction and oxidation of the hydrogen. The wire measured—

		Difference.
Before charge	443·25 m. m.	
With hydrogen	449·90 "	+ 6·65 m. m.
After discharge	437·31 "	− 5·94 "

The retraction of the wire, therefore, does not require the concurrence of a high temperature. This experiment further proved that a large charge of hydrogen may be removed in a complete manner by exposure to the positive pole—for four hours in this case; for the wire in its ultimate state gave no hydrogen on being heated *in vacuo*.

That particular wire, which had been repeatedly charged with hydrogen, was once more exposed to a maximum charge, for the purpose of ascertaining whether or not its elongation under hydrogen might now be facilitated and become greater, in consequence of the previous large retraction. No such extra elongation, however, was observed on charging the retracted wire more than once; and the expansion continued to be in the usual proportion to the hydrogen absorbed. The final density of the wire was 12·18.

The wire retracted by heat is found to be altered in another way, which appears to indicate a molecular change. When the gas has been expelled by heat, the metal gradually loses much of its power to take up hydrogen. The last wire, after it had already been

operated upon six times, was again charged with hydrogen for two hours, and was found to occlude only 320 volumes of gas, and in a repetition of the experiment, 330·5 volumes. The absorbent power of the palladium had therefore been reduced to about one-third of its maximum.

The condition of the retracted wire appeared, however, to be improved by raising its temperature to full redness, by sending through it an electrical current from a battery. The absorption rose thereafter to 425 volumes of hydrogen, and in a second experiment to 422·5 volumes.

The wire becomes fissured longitudinally, acquires a thready structure, and is much disintegrated on repeatedly losing hydrogen; particularly when the hydrogen has been extracted by electrolysis in an acid fluid. The palladium in the last case is dissolved by the acid to some extent. The metal appeared, however, to recover its full power to absorb hydrogen, now condensing upwards of 900 volumes of gas.

The effect upon its length of simply annealing the palladium wire by exposure in a porcelain tube to a full red heat, was observed. The wire measured 556·075 m.m. before, and 555·875 m.m. after heating; or a minute retraction of 0·2 m.m. was indicated. In a second annealing experiment, with an equal length of new wire, no sensible change whatever of length could be discovered. There is no reason, then, to ascribe the retraction after hydrogen, in any degree, to the heat applied when the gas is expelled. Palladium wire is very slightly affected in physical properties by such annealing, retaining much of its first hardness and elasticity.

2. *Tenacity.*—A new palladium wire, similar to the last, of which 100 m.m. weighed 0·1987 grammes, was broken, in experiments made on two different portions of it, by a load of 10 and of 10·17 kilogrammes. Two other portions of the same wire, fully charged with hydrogen, were broken by 8·18, and by 8·27 kilogrammes. Hence we have—

Tenacity of palladium wire	100·
Tenacity of palladium and hydrogen	81·29

The tenacity of the palladium is reduced by the addition of hydrogen, but not to any great extent. It is a question whether the degree of tenacity that still remains is reconcilable with any other view than that the second element present possesses of itself a degree of tenacity such as is only found in metals.

3. *Electrical Conductivity.*—Mr. Becker, who is familiar with the practice of testing the capacity of wires for conducting electricity, submitted a palladium wire, before and after charging with hydrogen, to trial, in comparison with a wire of German silver of equal diameter and length, at 10·5°. The conducting-power of the several wires was found as follows, being referred to pure copper as 100:—

Pure copper	100·
Palladium	8·10
Alloy of 80 copper + 20 nickel	6·63
Palladium + hydrogen	5·99

A reduced conducting power is generally observed in alloys, and the charged palladium wire falls 25 per cent. But the conducting power remains still considerable, and the result may be construed to favor the metallic character of the second constituent of the wire. Dr. Matthiessen confirms these results.

4. *Magnetism.*—It is given by Faraday as the result of all his experiments that palladium is "feebly but truly magnetic;" and this element he placed at the head of what are now called the paramagnetic metals. But the feeble magnetism of palladium did not extend to its salts. In repeating such experiments, a horse-shoe electro-magnet of soft iron, about 15 centimetres (6 inches) in height, was made use of. It was capable of supporting 60 kilogs., when excited by four large Bunsen's cells. This is an induced magnet of very moderate power. The instrument was placed with its poles directed upwards; and each of these was provided with a small square block of soft iron terminating laterally in a point, like a small anvil. The palladium under examination was suspended between these points in a stirrup of paper attached to three fibres of cocoon silk, 3 decimetres in length, and the whole was covered by a bell glass. A filament of glass was attached to the paper, and moved as an index on a circle of paper on the glass shades divided into degrees. The metal, which was an oblong fragment of electro-deposited palladium, about 8 m.m. in length and 3 m.m. in width, being at rest in an equatorial position—that is, with its ends averted from the poles of the electro-magnet—the magnet was then charged by connecting it with the electrical battery. The palladium was deflected slightly from the equatorial line by 10° only; the magnetism acting against the torsion of the silk suspending thread. The same palladium charged with 603·6 volumes of hydrogen was de-

flected by the electro-magnet through 48°, when it set itself at rest. The gas being afterwards extracted, and the palladium again placed equatorially between the poles, it was not deflected in the least perceptible degree. The addition of hydrogen adds manifestly, therefore, to the small natural magnetism of the palladium. To have some terms of comparison, the same little mass of electro-deposited palladium was steeped in a solution of nickel of specific gravity 1·082, which is known to be magnetic. The deflection under the magnet was now 35°, or less than with hydrogen. The same palladium being afterwards washed and impregnated with a solution of protosulphate of iron of specific gravity 1·048, of which the metallic mass held 2·3 per cent. of its weight, the palladium gave a deflection of 50°, or nearly the same as with hydrogen. With a stronger solution of the same salt, of specific gravity 1·17, the deflection was 90°, and the palladium pointed axially.

Palladium in the form of wire or foil gave no deflection when placed in the same apparatus, of which the moderate sensitiveness was rather an advantage in present circumstances; but when afterwards charged with hydrogen, the palladium uniformly gave a sensible deflection of about 20°. A previous washing of the wire or foil with hydrochloric acid, to remove any possible traces of iron, did not modify this result. Palladium reduced from the cyanide, and also precipitated by hypophosphorus acid, when placed in a small glass tube, was found to be not sensibly magnetic by our test; but it always acquired a sensible magnetism when charged with hydrogen.

It appears to follow that hydrogenium is magnetic, a property which is confined to metals and their compounds. This magnetism is not perceptible in hydrogen gas, which was placed both by Faraday and M. E. Becquerel at the bottom of the list of diamagnetic substances. This gas is allowed to be upon the turning-point between the paramagnetic and the diamagnetic classes. But magnetism is so liable to extinction under the influence of heat that the magnetism of a metal may very possibly disappear entirely when it is fused or vaporized, as appears with hydrogen in the form of gas. As palladium stands high in the series of the paramagnetic metals, hydrogenium must be allowed to rise out of that class, and to take place in the strictly magnetic group, with iron, nickel, cobalt, chromium and manganese.

Palladium with Hydrogen at a High Temperature.—The ready

permeability of heated palladium by hydrogen gas would imply the retention of the latter element by the metal even at a bright red heat. The hydrogenium must, in fact, travel through the palladium by cementation, a molecular process which requires time. The first attempts to arrest hydrogen in its passage through the red-hot metal was made by transmitting hydrogen gas through a metal tube of palladium with vacuum outside, rapidly followed by a stream of carbonic acid, in which the metal was allowed to cool. When the metal was afterwards examined in the usual way, no hydrogen could be found in it. The short period of exposure to the carbonic acid seems to have been sufficient to dissipate the gas. But on heating palladium foil red-hot in a flame of hydrogen gas, and suddenly cooling the metal in water, a small portion of hydrogen was found locked up in the metal. A volume of metal amounting to 0·062 c. c. gave 0·080 c. c. of hydrogen; or, the gas, measured cold, was 1·306 times the bulk of the metal. This measure of gas would amount to three or four times the volume of the metal at a red heat. Platinum treated in the same way appeared also to yield hydrogen, although the quantity was too small to be much relied upon, amounting to only 0·06 volume of the metal. The permeation of these metals by hydrogen appears, therefore, to depend on absorption, and not to require the assumption of anything like porosity in their structure.

The highest velocity of permeation observed, was in the experiment where four litres of hydrogen (3992 c. c.), per minute passed through a plate of palladium 1 m. m. in thickness, and calculated for a square metre in surface, at a bright red heat a little short of the melting point of gold. This is a traveling movement of hydrogen through the substance of the metal with the velocity of 4 m.m. per minute.

The chemical properties of hydrogenium also distinguish it from ordinary hydrogen. The palladium alloy precipitates mercury and calomel from a solution of the chloride of mercury without any disengagement of hydrogen; that is, hydrogenium decomposes chloride of mercury, while hydrogen does not. This explains why M. Stanislas Meunier failed in discovering the occluded hydrogen of meteoric iron, by dissolving the latter in a solution of chloride of mercury; for the hydrogen would be consumed, like the iron itself, in precipitating mercury. Hydrogen (associated with palladium) unites with chlorine and iodine in the dark, reduces a persalt

of iron to the state of protosalt, converts red prussiate of potash into yellow prussiate, and has considerable deoxidizing powers. It appears to be the active form of hydrogen, as ozone is of oxygen.

The general conclusions which appear to flow from this inquiry are—that in palladium fully charged with hydrogen, as in the portion of palladium wire now submitted to the Royal Society, there exists a compound of palladium and hydrogen in a proportion which may approach to equal equivalents;* that both substances are solid, metallic and of a white aspect; that the alloy contains about 20 volumes of palladium united with one volume of hydrogenium; and that the density of the latter is about 2, a little higher than magnesium, to which hydrogenium may be supposed to bear some analogy; that hydrogenium has a certain amount of tenacity, and possesses the electrical conductivity of a metal; and, finally, that hydrogenium takes its place among magnetic metals. The latter fact may have its bearing upon the appearance of hydrogenium in meteoric iron, in association with certain other magnetic elements.

I cannot close this paper without taking the opportunity to return my best thanks to Mr. W. C. Roberts for his valuable co-operation throughout the investigation.

SPECTROSCOPIC OBSERVATIONS OF THE SUN.

By J. N. Lockyer.

The author, after referring to his ineffectual attempts, since 1866, to observe the spectrum of the prominences with an instrument of small dispersive powers, gave an account of the delays which had impeded the construction of a larger one (the funds for which were supplied by the Government-Grant Committee, early in 1867,) in order that the coincidence in time between his results and those obtained by the Indian observers might not be misinterpreted.

Details are given of the observations made by the new instrument, which was received incomplete on the 16th of October. These observations include the discovery and exact determination of the lines of the prominence spectrum on the 20th of October, and of the fact that the prominences are merely local aggregations

* *Proceedings of the Royal Society*, 1868, p. 425.

of a medium which entirely envelopes the sun. The term chromosphere is suggested for this envelope, in order to distinguish it from the cool absorbing atmosphere on the one hand, and from the white light-giving photosphere on the other. The possibility of variations in the thickness of this envelope is suggested, and the phenomena presented by the star in Corona are referred to.

It is stated that, under proper instrumental and atmospheric conditions, the spectrum of the chromosphere is always visible in every part of the sun's periphery; its height, and the dimensions and shapes of several prominences, observed at different times, are given in the paper. One prominence, 3′ high, was observed on the 20th of October.

Two of the lines correspond with Fraunhofer's C and F; another lies 8° or 9° (of Kirchhoff's scale) from D towards E. There is another bright line, which occasionally makes its appearance near C, but slightly less refrangible than that line. It is remarked that the line near D has no corresponding line ordinarily visible in the solar spectrum. The author has been led, by his observations, to ascribe great variation of brilliancy to the lines. On the 5th of November, a prominence was observed in which the action was evidently very intense; and on this occasion the light and color of the line at F were most vivid. This was not observed all along the line visible in the field of view of the instrument, but only at certain parts of the line which appeared to widen out.

The author points out that the line F invariably expands (that the band of light gets wider and wider) as the sun is approached, and that the C line and the D line do not; and he enlarges upon the importance of this fact, taken in connection with the researches of Plücker, Hittorf, and Frankland on the spectrum of hydrogen—stating at the same time that he is engaged in researches on gaseous spectra which, it is possible, will enable us to determine the temperature and pressure at the surfaces of the chromosphere, and to give a full explanation of the various colors of the prominences which have been observed at different times.

The paper also refers to certain bright regions in the solar spectrum itself.

Evidence is adduced to show that possibly a chromosphere is, under certain conditions, a regular part of star economy, and the outburst of the star in Corona is especially dwelt upon.—*Chemical News.*

THE TOTAL ECLIPSE OF THE SUN,

August 18th, 1868.

In looking over our late numbers, we find that we have been negligent in keeping our readers informed of the observations made during the unusual phenomenon above named, the reason being, that the news of what had been done and seen at the distant points of observation in Arabia and India, reached this part of the world in such minute fragments, that the proper time to publish a connected account never seemed to come, as something was always wanting to render the story complete.

Now, however, at last we have enough to make a respectable array, and though much is yet to be looked for (no details or drawings by the French party having been published), we will endeavor to put into satisfactory shape the existing material.

Six parties were sent out by various governments, societies, or individuals.

One from the Royal Society, under Lieut. Herschel, located itself at Belgaum, in India; another from the Royal Astronomical Society, under Major Tennant, went to Guntoor, in India, at which place a French party under M. Janssen, who represented the Académie des Sciences, also established itself. Another French party under M. Stephan, posted themselves at Wah-Tonne, on the peninsula of Malacca. While a Prussian corps, under Dr. Vogel, took their ground at Aden, in Arabia, near the mouth of the Red Sea. A few individual observers were stationed at intermediate points, while, lastly, an English party, under Capt. Haig, fixed upon Beejapoor, in India.

Fig. 1 on the plate, shows the location of these various points in connection with the path of the totality, which, in the case of this eclipse, had a breadth of 143 miles, and a maximum duration of nearly *seven minutes*, which is without a parallel in the annals of astronomy.

The special points to which attention was directed by all parties, were—

1st. Photographic records of the phenomena.

2d. Observation of the protuberances.

3d. Observation of the corona with the polariscope.

4th. Observation of the corona and protuberances with the spectroscope.

TOTAL ECLIPSE OF THE SUN AUG 17-18, 1868.

Fig 1.

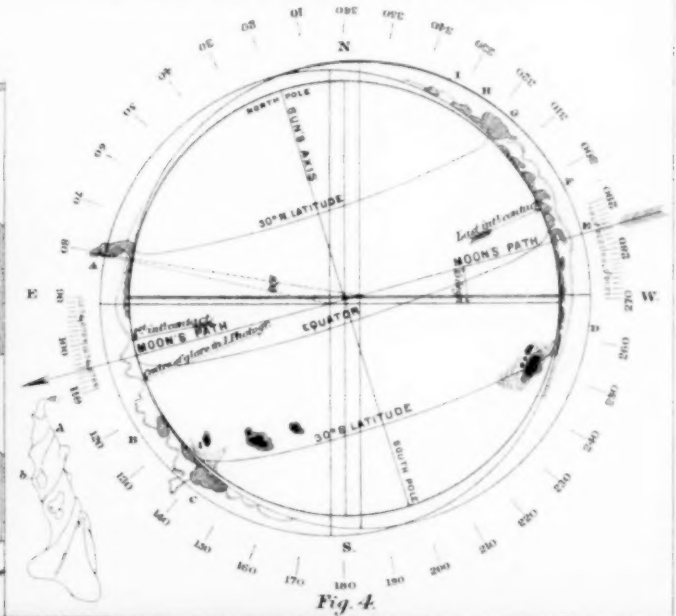
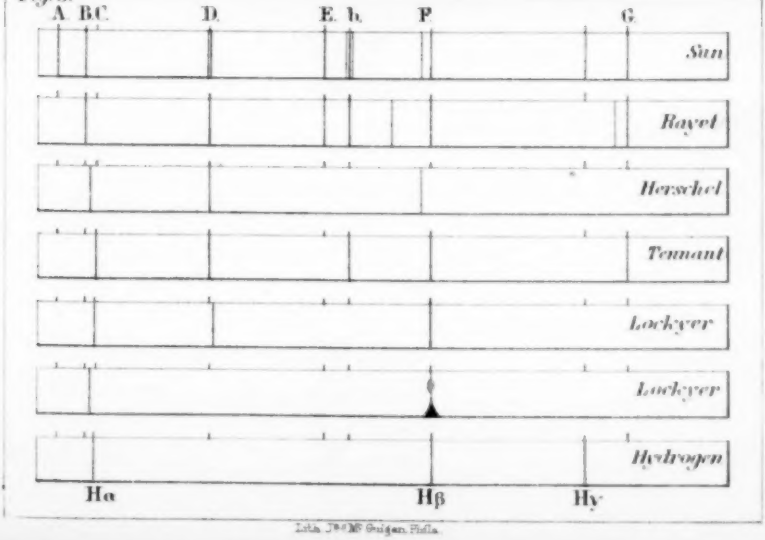


Fig. 4.

Fig. 2

Fig. 5.



Lith. J. & M. Gugan, Phila.

The only photographs which have been generally circulated, are those taken by the Prussian or North German expedition, under Dr. Vogel. One of these was sent by this gentleman some time since, to Mr. E. L. Wilson, editor of the *Philadelphia Photographer*, and other copies are to be placed in his hands for sale. We hope in our next number to give copies of these photographs, but for the present will only refer to the outlines Figs. 2 and 3, on the plate, which will serve to indicate the general features shown in these pictures, and which we have copied through the kindness of Mr. Wilson, from those first sent to him.

Figure 2 indicates the objects seen in the plate exposed at the first moment of totality. These consist chiefly of a long series of flame like prominences, stretching for a distance of at least 500,000 miles along the edge of the sun, and composed of more brilliant central masses, with tongues and fringes of fainter light The impression which this photograph conveys, is of a vast conflagration, blown by a wind from left to right, and seen over the edge of a serrated range of hills. The flame-like appearance of these luminous protuberances, must, however, be regarded only as an accidental similarity in shape, as there are many reasons which make the existence of anything like true combustion in these regions extremely improbable.

These luminous bodies, as we shall presently see from the results of the spectroscopic observations, are undoubtedly cloud-like masses of intensely hot, but not burning, gas; of gas which in fact is far hotter than any combustion could make it.

Following round the solar and lunar edge to the right, we then encounter a tower-like mass of similar luminous matter, which on comparison with the solar radius, is found to be nearly 70,000 miles high, and about 10,000 miles across the base. Assuming, as we have good reason to do, that its other dimension is about the same, we find that its entire volume would approach 7,000,000,000,000 of cubic miles, or 27 times the earth's entire bulk, or enough to cover us in to the depth of some 8,000 miles, with an atmosphere of a constant density, our own atmosphere under the same condition being only sufficient to reach about 5 miles.

Fig. 3 represents the picture obtained by Dr. Vogel and his party during the *last* moments of totality; it shows a range of low-lying luminous cloud-matter, ill defined and with no remarkable characteristic. The weather at this station was very unfavorable, the

sky being covered with clouds, as is proved by a picture taken a few minutes after the totality, in which the crescent sun is seen enveloped in, and almost obscured by thick clouds.

The pictures taken by Major Tennant, were, according to his own first account, very unsatisfactory, being "under-exposed, and covered with spots." On subsequent examination, however, he found the negatives better than he had expected, and from a set of prints which he transmitted to Mr. Warren De la Rue, that gentleman has prepared and published in the Monthly Notices of the Royal Astronomical Society, the drawing, of which, Fig. 4, is a slightly reduced copy. Major Tennant also sends an enlarged drawing of the tower-like projection already described, which he names appropriately a horn, and in which his pictures show unmistakable evidence of a spiral structure. **A** *a b* in the left-hand lower corner of Fig. 4 is a copy from this. A similar spiral structure is shown in one of the prominences taken by De la Rue in the eclipse of 1860.

Major Tennant estimates the height of this great horn or spiral as 90,000 miles.

Mr. De la Rue from a comparison of various drawings, published in the *London Engineer*, supposes that this horn was rotating about its axis. Thus, the difference in actual time between the appearance of the eclipse at Aden and Guntoor was forty minutes; during which a semi-rotation seems, by the pictures, to have occurred; so in the forty-nine minutes between Guntoor and Wha-Tonne, another half turn, and so on, with decreasing velocity.

On Fig. 4, have been introduced in their proper places, the sun-spots present at the date of the eclipse, as shown by the photographs regularly taken at the Kew Observatory. No other connection appears to exist between them and the luminous protuberances, except that both are excluded from the circum-polar regions.

This drawing also shows how entirely the solar disk was overlapped by that of the moon, which was of course the reason of the great breadth of the shadow, and the unusual duration of the totality.

Observations with the polariscope upon the corona, are thoroughly accordant from all stations, and indicate that the light was polarized in plains passing through the sun's centre, as it should be if it consists simply of light reflected by particles of matter surrounding the sun.

Observations upon the corona, with the spectroscope, either gave

no result, or showed a very faint and apparently continuous spectrum.

The luminous prominences, however, showed themselves to be gaseous, and gave marked spectra, in which the various lines delineated in Fig. 5, were recognized by the different observers, as there set down. The lines upon which nearly all observers seem to agree are. A red line corresponding with Fraunhofer's line C, a yellow one at or near D, a blue one coinciding with F, and a violet one corresponding with G.

The correspondence of three of these lines with those derived from the light of hydrogen heated by an electric discharge, is very marked. Thus, as Plucker, by whom this subject was developed, states (*Phil. Trans.* 1865, p. 20, Note). The red line of hydrogen coincides with C, its blue line with F, and its violet with a marked line a little short of G. (See Plate, Fig. 5, last spectrum.)

It would thus seem to be extremely probable that hydrogen is a main constituent of these prominences, a fact which is further established by other circumstances. Thus, hydrogen, when so heated as to give out light resolvable into the three lines mentioned as above, and indicated in Fig. 5, has a brilliant rose color, which agrees with the tint observed in the solar prominences. Again, Lockyer, when studying the spectra of these prominences without the aid of an eclipse, in the manner described by us on p. 87, found that the blue line corresponding to Fraunhofer's F, was much expanded at its base, or part nearest the sun. (See Fig. 5, spectrum next to last.) This would naturally be its hottest part. Now, on turning to Plucker's paper in the *Philosophical Transactions*, in which the experiments with gases, heated in tubes by the electric discharge and observed with a spectroscope, are recorded, we find (*Phil. Trans.*, Vol. 155, p. 21), "Hydrogen shows in a most striking way the expansion of its spectral lines and their gradual transformation into a continuous spectrum. When the direct discharge of Ruhmkorff's large induction coil is sent even through the old spectrum tubes, enclosing hydrogen, the formerly obtained spectrum is essentially altered."

"By increasing the power of the coil, the violet line $H\gamma$* first expands; while it continues to expand, the expansion of the bluish line, $H\beta$, becomes visible."

* These symbols, $H\alpha$, $H\beta$, and $H\gamma$ are used by Plucker to indicate the lines in hydrogen corresponding to C, F, and the one near G in the solar spectrum. (See Fig. 5, last line.

"Let the aperture of the slit be regulated so that the sodium line will separate into two single lines nearly touching each other. Then, the angular breadth of Hβ becoming two or three minutes, the breadth of Hγ is about double. The expansion takes place as well towards the less as towards the more refracted part of the spectrum, Hα, remains almost unchanged after Hγ has passed into an undetermined large violent band, and Hβ extended its decreasing light on its two sides. On employing the Leyden jar, and giving to the gas in our new tubes a tension of about sixty millions, the spectrum is already transformed into a continuous one, with a red line at one of its extremities."

From this, it is not only obvious that the temperature of these protuberances is greater in one part than in another, (the highest heat, as is natural, being in the part nearest the sun, but also that the peculiar action of their light under this condition corresponds with that of hydrogen; for though a similar expansion of lines takes place with other gases under the influence of intense heat, in none is it so marked or so regular as with hydrogen.

As will be seen in an abstract published in this number, p. 266, Lockyer proposes to make this point a special subject for investigation, and very interesting results may be confidently expected.

Besides these lines, indicative of hydrogen, most observers also agree as to the presence of a yellow band in the place of D of the solar spectrum. This would indicate vaporized sodium. Lockyer in his study of the prominences, without the eclipse, states that appearances indicated the difference in constitution of various prominences. Thus, he occasionally observed a new red line below C, as shown in Fig. 5.

By his method of observation, the comparison of lines and determination of position is specially easy, for, as will be seen by reference to p. 87 of this *Journal*, the spectrum of the prominence is seen in contact with a faint solar one, so that the coincidence of lines may be recognized with the utmost facility. Observing in this way, he reports that the yellow line does not correspond with D, but is distant from it by eight or nine degrees of Kirchhoff's scale.

Several other lines were recorded by M. H. Rayet, about which it would hardly be safe to hazard any conjecture, except in the case of one also observed by Major Tennant. This was of a green color, and corresponded in position with *b* of the solar spectrum. A simi-

lar line is developed both by iron and magnesium when vaporized. The line coincident with E, seen by M. Rayet, might also be due to the former metal.

We look with great interest for the account of the observations made by the French party at Guntoor. They seem to have enjoyed admirable weather, and if their photographic arrangements and manipulations were good, they may have secured some very important results. Thus it will be remembered that in the photographs of the total eclipse of 1860, taken by Warren de la Rue (*Phil. Trans.*, Vol. CLII., p. 333) a number of prominences were shown in the photographs which were not seen by the observers with the telescope, even in places where especial examination had been made by reason of some peculiarity in the objects noticed.

In the last eclipse, we have, however, as yet heard of nothing of this kind. This is quite explicable, if we consider that the German photographers, who managed their process with the greatest skill, had the most unpropitious weather, the sky being full of clouds, which must have absorbed every trace of the invisible but actinic rays, while the English party at Guntoor, who had admirable weather, allowed their baths to be concentrated by the heat of the climate, and over-exposed all their pictures.

It is much to be lamented that Mr. De la Rue adhered to his vow, made during the former eclipse, of not attempting instrumental observations of another, and it is to be devoutly hoped that though our Government has refused any assistance towards the observation of the eclipse which will be visible in this country next August, some public institutions or private individuals will be excited to imitate the above mentioned gentleman, who, in 1860, expended $1,500 of his own funds, in the necessary preparations and conduct of his observations, although in his case, a Government appropriation was made of all that he named as the estimated cost, and a ship of war was put at his disposal for the transportation of his material and assistants.

The eclipse next August will be total over a belt 100 miles in width, and running from Alaska to Beaufort, North Carolina. It will occur on the 18th, about noon, at Alaska, and near sunset, at North Carolina.

EDUCATIONAL

SUNLIGHT AND MOONLIGHT.

A Lecture delivered at the Academy of Music, before the Franklin Institute, on May 23d and June 6th, 1868.

By Prof. Henry Morton, Ph. D.

(Continued from page 208.)

In the preceding description of a sun-spot, mention was made of the "faculæ," which are appearances we have not yet described.

When the general surface of the sun is observed with a moderate magnifying power, it is seen to be of irregular brightness, the appearance being such as we can perhaps best explain by describing at once the object and its probable cause.

The idea suggested most naturally to the observer, is that he is looking at an expanse of variegated white cloud, rolled over in a long irregular ridge in one place, heaped into a broader mass at another, and composed of intersecting ridges at yet another point. These more luminous parts are called "faculæ," and it seems reasonable to believe that they are in fact what they appear to be, accumulations of that luminous cloudy matter of which the visible solar surface consists. These faculæ are especially distinct near the edge of the sun's disk, and in the vicinity of sun spots, and are often seen after the disappearance of a spot round the sun's edge, as in the case mentioned on p. 200. Besides these larger objects, the entire surface not occupied by spots has a mottled appearance, as though covered with luminous specks, which have been variously named "willow leaves," "rice grains," "granules," &c., according to the resemblance suggested to the minds of different observers. These markings are of the most irregular figure, as would appear from the testimony of the majority of observers, although some have defined them as possessing a marked regularity in outline, and one sober and discreet astronomer, no other than Sir John Herschel, has even hazarded so wild a conjecture as the following. He says, after describing them as the sources to us of the sun's light and heat, "Looked at in this point of view, we cannot refuse

to regard them as *organisms* of some peculiar and amazing kind; and though it would be too daring to speak of such organization as partaking of the nature of life, yet we do know that vital action is competent to develop both heat, light and electricity. These wonderful objects can hardly be less than a thousand miles in length, and two or three hundred in breadth." (Lectures on Scientific Subjects, p. 84.)

As a rule, these granules are of an elongated shape, and are arranged with no order as regards their direction; but around the edges of spots they generally point with their longer axis towards the centre of the spot, and give a thatch-like appearance to the penumbra, as is indicated in Figs. 4 and 5 of Plate VII., facing p. 206. On some occasions, one or more of these granules has been seen to break loose, and as it were, set sail across the dark portion of a spot.*

The most probable theory as to the nature of these objects, seems to be that which we have before noticed, and which describes them as cloud-caps at the summit of rising streams of vapor, where the material of which they are composed has reached a sufficient condensation to be a source of white light.

There have also been observed on the less brilliant spaces between these white granules, numerous minute dark points like stiplings with a soft lead pencil. These have been called "pores," by Sir John Herschel, and "punctulations" by his father. They are too minute to enable us to reach any conclusion as to their meaning.

Before leaving this class of phenomena connected with the solar surface, we should say that the abundance of sun spots varies in regular periods from a maximum in frequency and extent, through a minimum to a new maximum, in a period of eleven years, coinciding with a like period in the occurrence of auroræ and magnetic disturbances experienced in the earth, and appearing to be so related to the motions of the planets Venus and Jupiter (the first being effective by reason of its propinquity and the second by its mass), that it is but reasonable to suppose that the presence of these planets is influential upon this solar action.

(To be continued.)

* *Monthly Notices, Royal Astronomical Society*, 1865, *p.* 236.

LECTURES ON VENTILATION.

By Lewis W. Leeds.

Second Course, delivered before the Franklin Institute, during the winter of 1867–68.

(Continued from page 204.)

Now, I think we should be able to apply these *principles* to the heating and ventilation of rooms.

We must study to comprehend the principles, because the circumstances surrounding us are varying so constantly that such arrangements as would suit us best at one time, would not be good at another.

A primary condition to be observed in all heating and ventilating arrangements, as before alluded to, is to keep the feet warmer than the head, and the back warmer than the face.

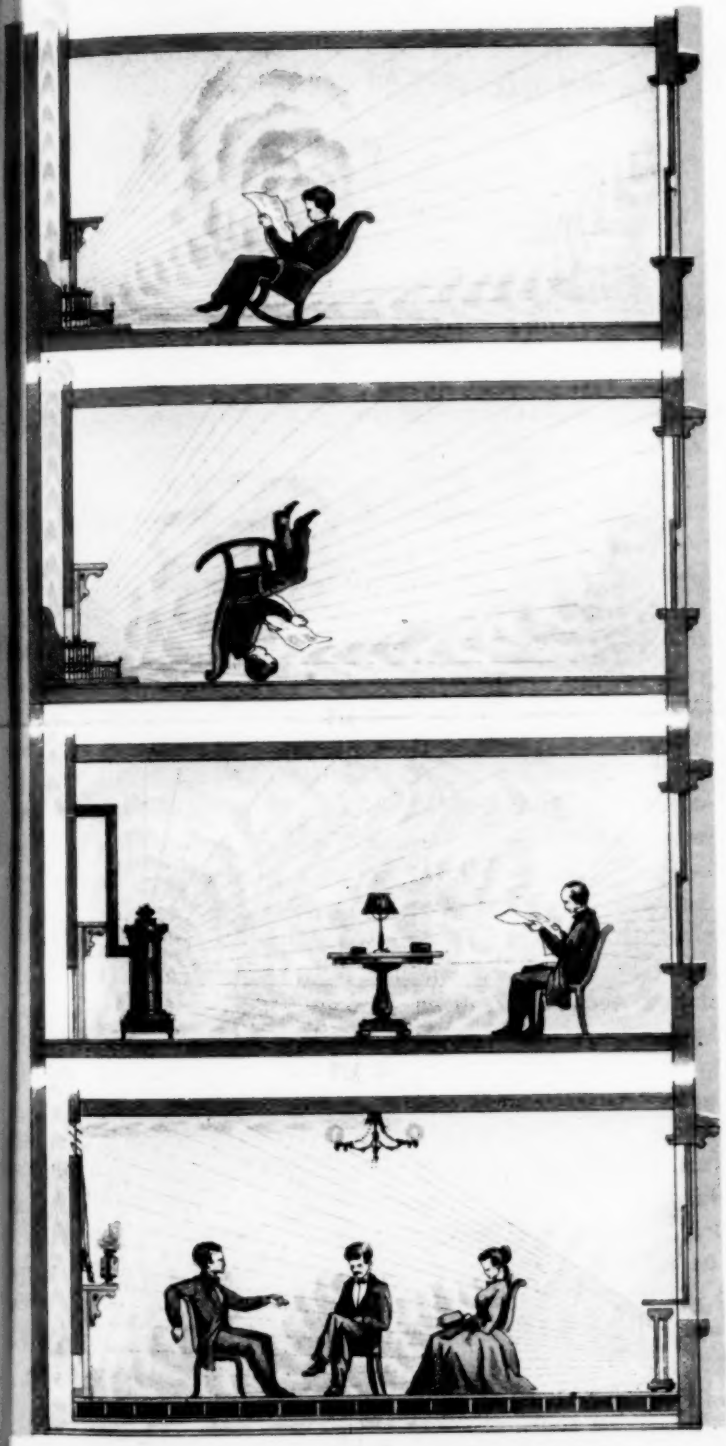
These are great natural provisions, as in walking, or when in motion we face the current. We inhale from the air in front of us, and the fouled air is carried behind us. Therefore, for better protection, probably the greater portion of the nerves are concentrated near the spine; consequently, if the back is chilled, the whole system is put out of order; and more care is required to keep the feet warm, because, being farthest from the heart, the blood is more liable to become chilled, but if the extremes are kept warm, of course the intermediate parts must necessarily be so.

The sun's rays falling upon the earth's surface, and heating our feet hotter than the air around us, is a beautiful illustration of this principle.

Nearly all animals except man, secure this condition by building their houses, or burrowing below the ground, so that the warmth of their bodies causes the foul air to flow out, while the cool fresh air to supply its place, must come in from above, and consequently fall upon their heads first.

It must be admitted that most of our arrangements for ventilation and warming do not fully meet these requirements; indeed, a careful examination will reveal the fact that many of them are as absurd and unscientific as they can well be made.

I have here a diagram (see lithograph Plate, Fig. 1), which has been prepared to represent the condition of different parts of the room, when heating exclusively by open fires.



I have been unable to invent or think of any simple method of showing the actual passing or currents of radiant heat.

It is one of the most difficult points to comprehend in connection with the subject of heating and ventilation. It is also one of the most important.

In this diagram, we have resorted to colors to express our ideas. By the blue is designated the strong current of cold air that is always found flowing along the floor from the windows and doors towards the open fire; and of course the feet and back of those sitting with their faces to the fire, are most affected by this cold air. It may at times be but little above the freezing point; but directly in opposition to this current there is a strong radiation from the bright fire, directly into the face and front of those sitting before it.

We must remember the direct radiation from an open fire or other hot body is not disturbed by the current of air.

Now to get his back warmer than his face, and his feet warmer than his head, it will be necessary to change his position. (Fig. 2.)

I admit, this is rather an awkward position. You know the conventional way for an Englishman to represent a Yankee, is to have him tilted back in a chair, with his feet on the mantel, or in some position higher than his head.

So you see there is a little more practical common sense about this position of the universal Yankee, than it would at first appear.

Now, I do not suppose this will become a fashionable way of sitting, even if the physiologists were to recommend it. But if we want to be really comfortable and healthy, we shall have to change either our manner of sitting, or our manner of heating and ventilation.

Let us consider this open fire question a little carefully, because there are some very good points about it. The heat derived from actual combustion, that is from an open fire, is the purest artificial heat we can possibly have. The temperature of the burning coals or wood is over 3,000°, and the flow of radiant heat therefrom more nearly imitates the sun than from surfaces of a lower temperature.

This is the strongest point in its favor. It is also impossible to prevent its being a good ventilator. And this is no small account to its credit, as it is almost the only ventilation that the people, in their ignorance, do not stop up.

But it also has its disadvantages, which have prevented, and always must prevent its coming into universal use for heating exclusively.

One of these is represented by the diagram in the very uneven manner of distributing the heat, and as it heats the head hotter than the feet, and the face hotter than the back, we shall have to ignore it altogether, or what I think will do better, get some additional assistance partially to warm the air before it enters.

Let us now consider the great abuse of the system of heating by direct radiation. We have prepared some tanks for using in the lantern, and by using liquids of different colors and densities, I think we shall be able to express to you some of the principal movements of air of different temperatures.

If you will notice carefully, you will soon see that the liquids used to night are governed by the same laws, and move in almost precisely the same manner, as the air and gases of different densities that we used the other evening.

Professor Morton has very kindly offered to assist me this evening, and has now placed in the lantern a small tank, and by the aid of the new Zentmayer prism, shall be able to show you the image on the screen, just in its natural position.

This we could not have done last year, without the aid of this prism, and as we would have had to work everything bottom upwards, I did not then use the lantern for this purpose.

At the left hand corner of our room, (Fig. 3), you see the shadow of a small coil, which is fine platina wire. Professor Morton will connect the two ends of that coil with a small battery, and thus put a current of electricity through it, by which it will be heated, and you will very soon see the liquid around that coil (represented by stove in the figure) beginning to ascend. And now you see, as the air around the stove commences to rise, the air from below flows in to take its place, thus giving a revolving motion to all the liquid in the room.

You also notice the figure of a man sitting very quietly, with his back to the window, as though he was in a profound meditation.

We will have to disturb his quiet a little, I think.

(*Here the figure was made to breathe.*)

You see, the breath being loaded with carbonic acid and moisture, falls directly to the floor, and mingling with the revolving mass, will soon be carried quite around the room, and back again to be re-breathed

Now, here is a combination of warming by direct radiation, and warming the air also by its coming in contact with the stove.

Now please take especial notice of the conditions here represented. This applies to a large number of our ordinary buildings heated by steam, when the coils are placed directly in the room.

It also very nearly applies to rooms heated by air-tight stoves, as there is so little air consumed in them to support combustion, it is hardly worth noticing as ventilation.

The air is already becoming very foul, as it inevitably does, in rooms treated in this manner, when no attention is given to having a regular supply of air.

It allows the room and all its inmates to be sealed up perfectly air-tight. It not only *allows* it to be done, but we generally find that advantage is taken of this opportunity to close all cracks, and it is most zealously accomplished.

There is one other point of much practical importance represented in this: that is, in sitting with the back towards a cold window; the additional warmth or animal heat of the body will be radiated to and absorbed by this cold window. And thus the very being, life and vitality will be abstracted, and spinal disease, rheumatism, and other disorders, are the results frequently of continued sitting in this position. Therefore, never sit with your back to a window. It will be observed, that the cooling of the air by its coming in contact with the window, by no means purifies it.

Now, this is the great *abuse* of direct radiation; the way a large proportion of our buildings and rooms are arranged. I think we can make an improvement on this. (Fig. 4.)

In the first place, the heating surface is represented in this case as a coil of steam pipe but it may be an open fire or stove or any other heating arrangement, and is placed on the cold side of the room and directly under the window, which, being but thin glass, is generally the coldest part of the room.

Now, by raising the window a little, there will be a current of fresh air blowing directly against this heating surface; the entering air will thus be partially warmed. It need not be warmed to the temperature of the room, however, because there will be a large proportion of the heat derived from the direct radiation of the exposed heater.

This gives the very great advantage of having cool, invigorating air for breathing, while the body is warmed by the direct rays from

the fire or other heating surface. It also prevents those cold, unpleasant draughts so commonly complained of near windows.

The temperature of the fresh air, too, being so near the required temperature of the room, has no special tendency to rise immediately to the ceiling and escape through any opening that may be made there. On the contrary, being rather cooler, it is rather inclined to remain near the floor, except when it is additionally warmed by the persons, gas-lights, or some extra heating surface. The ventilation at the top of the room can always be left open without inconvenience, with this arrangement; this, too, is a very great advantage, as it should always be open in the evening under all circumstances, to carry off the products of combustion from the lights; and it is so difficult to have it opened in the evening and closed in the day time, with our present careless and indifferent notions about ventilation.

Therefore, an arrangement not requiring this daily attention, is valuable.

The figure represents an additional foul air channel under the floor. The air is represented by the arrows being drawn from the floor of the room around the base-board, or in schools or meeting-rooms when large numbers are assembled—from numerous points over the floor.

This frequently for large, crowded rooms, is an important arrangement. Of course these general plans will require many modifications in practice. But this combination of direct radiation and circulation of partially warmed air, and the placing of the heating surfaces on the cold sides of the room, and especially under the windows, will be found to be a hint of much value.

(To be Continued.)

ON THE FUTURE DEVELOPMENT OF SCIENTIFIC EDUCATION IN AMERICA.

By S. Edward Warren, C. E.

Prof. of Descriptive Geometry, &c., in the Rensselaer Pol. Ins'., Troy, N. Y.

(Continued from page 212.)

Each single institution would thus be regarded, not as an independent unit, but as a *free* component unit; first, of the entire assemblage of institutions of its own class; and, second, of the grandest unit, the aggregate of all the associated higher institutions of the land.

Each institution, and each enthusiastic thinker on the subject of higher education, would thus be emancipated from the idea that formal unity could be realized only through the appalling unwieldiness, consequent upon crowding instruction in every ancient and modern study, both general and technical, too, into a single institution. The original scheme of the "University of the South," with its thirty-two "Schools," so-called, was a marvellous example of this bombastic method of realizing the idea of unity. If we mistake not, there is a tendency to something of similar unwieldiness among some other and more prosperous institutions, arising probably from ambition not governed by some adequate regulating idea. Each institution would thus be happily free, both in conviction and feeling, to act on the wholesome principle, that the most finished results are to be obtained, by concentration of interest and effort upon a limited field, which should be more thoroughly cultivated.

We only add here, briefly, two more considerations.

First. The rehearsal, in new terms, of a cardinal principle already explained, viz., that general, or "liberal," and technical, or "professional" education are not rival competitors, on the same plane, as might be inferred from the large attendance on all professional schools, by those who are not college graduates; but that the latter are the natural successors of the former. Hence, that while each has its prevailing immediate end, by which it is distinguished, yet they are united by a general common end. That is, *proficiency in professional practice* is the *immediate* end of professional study, but the *remote*, though no less real end of general or collegiate study. In other words, a student would pursue a preliminary course in general science in order that he might become a better *student* of engineering, for example. He would *then* enter an engineering school, in order to qualify himself for the *immediate practice* of his profession.

Second. All men are self-educated who are educated by any activity at all of their own. The true alternative is, shall they educate themselves with, or without the helps afforded by experienced teachers? The obvious answer is, of itself, the grand justification of the existence of all institutions for purposes of *formal* education. But every influence in life that has any effect upon man is, so far, an educating influence. There is, then, an *informal* or unconscious education going on through every conscious moment of existence,

in the schools of the home, the church, the street, the shop, &c.; and this is why a programme of *formal* education need not embrace every educating element under the heads of observation, experiment, reflection and practice, upon and with Man and Nature.

Curriculum, and remarks thereon.

TOTAL COURSE = Five Years.

General Course = Three Years.

Technical Courses = Two Years each, in

Civil Engineering. {
- Construction Engineering,
- Mechanical Engineering,
- Mine Engineering,
- Industrial Architecture.

Remarks (*A*).—According to the principles of unity already laid down, we cannot be clear in uniting more than these four technical courses in a single institution. Some persons, indeed, would perhaps prefer, and not without reason, that but one technical course should be given in any one institution, after a general course shaped with reference to that one. This would, indeed, secure the greatest simplicity of composition and concentration of energies on the simple principle of undertaking but one thing, and doing that one perfectly. But the four technical courses just named, are so closely related—three of them as merely subdivisions of *Civil*, as opposed to *Military Engineering*, and all, as based alike on the sciences of *Number* and *Form*, and they require so very much in common, in their preparatory general course, that there seems to be no decisive objection to assembling them in one school. To go further than this, would require nothing less than the study of the whole of Nature, in relation to Man's material wants, and would admit schools of *Topographical Engineering; Technical Natural Science* for the training of professional *Naturalists*, *Geologists*, *Physicists*, and *Chemists;* schools of *Industrial Ornamental Design*, of *Commerce and Trade*, of *Agriculture*, and of *Industrial Technology* as applied to the mechanical trades.

An institution embracing all the schools thus far mentioned would be what we have sometimes fancied as an all-embracing *Polytechnic University*, in distinction from the equally broad *Humanistic University*, in which man and his personal wants should be the distinctive subject of study, thus giving rise to schools of *Law*, *Medicine*, *Divinity*, *Philology*, *Sociology*, and *Higher Teaching*.

But never, in the highest flights of ambitious fancy, could we imagine the union of these two universities in one to be desirable, so radical is the distinction between them. Yet, in the absence either of perception of, or regard for such a limiting distinction, the engrafting of schools of engineering, &c., upon classical colleges, looks to the supposed possibility of a university in which absolutely every branch of human knowledge and pursuit should be taught. It is not to be forgotten, however, that the great bequests often given to institutions may be coupled with conditions, whose fulfilment may conflict with the ideal views of higher educators.

We have already shown that it is not necessary, in order to realize the idea of a comprehensive unity in the higher seminaries, that each should teach everything. It is not even indispensable that there should be formal organizations, embracing the instructors in them. It is sufficient that what is *predominant in any of them* should have at least a *rudimentary representative in all;* according to the teaching of Nature in flowers, for example, where it often happens that organs, as the calyx, corrolla, or stamens, which are fully developed in one flower, exist only in a rudimentary form, or invisibly, in another. Thus it would probably be, best that a *University of Fine Arts*, to embrace thorough and professional training in *Music*, *Painting*, *Sculpture*, *Ornamental Architecture*, *Oratory*, and *Higher Gymnastics*, should be separate from the two species of Utilitarian Universities already described. Thus the *art idea* and *sentiment*, which would characterize such a University, would find its diminished representative to grace the life of *different* institutions in *their* possession of mere voluntary associations for music or field sports, of a *few* fine paintings and statues scattered through their halls, and of tasteful grounds.

(*B.*)—A course in *topographical engineering* is omitted from reasons of expediency simply. For, until the separate States of the Union institute state topographical surveys, the comparatively few engineers required on the coast survey can be supplied from the national institutions.

(*C.*)—The erection of fully equipped machine-shops, as a part of the means of instruction in schools of mechanical engineering, seems to us inexpedient. The regulating idea seems to be, that school education is an education primarily in *principles*, while that of the shop is a training in *processes*. Hence, while it doubtless would be well to keep a few standard working machines, and a

skilled mechanic to operate them, and to have students of mechanical engineering *see* the operations and have them explained, and be thoroughly interrogated upon them, it seems unnecessary, as it certainly would be impracticable, to make a skilled operative mechanic of every professional mechanical engineer. In addition, however, to seeing and noting the operations of machinists' tools, the student of mechanical engineering should have full opportunity, through a cabinet of machines and elementary combinations, to study the construction and action of the most important machines; always remembering that the profound study of a few illustrations confers more practical power than the shallow study of many.

(*D.*)—*Civil Engineering*, as opposed to *Military*, is a generic term, having, through the complexity of modern life, many separate departments, as has the Law.

Construction Engineering (so called for want of a better term, though *this* has precedent in high French authority,) might have been further subdivided into Road, Hydraulic, and Naval Engineering. The recognition of these as distinct departments, in a system of school instruction, would be only a question of time, depending on expediency.

PROVISION OF TIME.—Let the scholastic year, after deducting all vacations and holidays, yield 39 weeks of working days, in three equal sessions of 13 weeks each, from which further deduct 9 weeks, 3 from each session, for the principal reviews and examinations, leaving 30 weeks, at 5 days to the week, = 150 days. And let each student be present on duty, in theoretical and practical exercises, united, 5 hours daily, on an average, giving 750 hours per year as a maximum.

The granting of the whole of Saturday, every week, to the student, amply and duly provides for the *voluntary element in student life*, and thus enlivens and refreshes and contents it.

It also affords a most useful leeway, in which to equalize the products of unequal capacities and of unequal opportunities arising from necessary absences. The most capable can always find some profitable way of spending its hours, and, to the most hindered, it affords the great privilege of making up arrears before they can accumulate so as to become unmanageable.

And, best of all, it removes all excuse for neglect or waste of the invaluable privileges of Sunday, for the highest self-culture, and readjustment for the immediate future, through instruction and reflec-

tion upon the best, greatest, and most enduring things of both the past and the future.

With a liberal admixture of practical exercises, not requiring severe mental labor, and regarding field practice in Natural History and Geology as especially healthful, 5 hours daily for close study at home are contemplated, leaving 14 hours daily for sleep, meals, society, long or short recreations, and practical work at home.

(To be continued.)

Franklin Institute.

Proceedings of the Stated Monthly Meeting, Feb. 17th, 1869.

THE meeting was called to order, and in the absence of the President and Vice-Presidents, Mr. Samuel V. Merrick took the chair on motion.

The minutes of the last meeting were read and approved.

The Actuary submitted the minutes of the Board of Managers, and stated that the New Board, organized on the 27th January inst., by appointing the following Standing Committees for the ensuing year:—

1. *On Instruction.*

Henry Morton,
Coleman Sellers,
Robert E. Rogers,
Enoch Lewis,
Caleb S. Hallowell.

2. *On Elections and Resignations.*

O. Howard Wilson,
Henry G. Morris,
Henry Cartwright,
Samuel Hart,
Charles S. Close.

3. *On Stocks and Finance.*

William Sellers,
Frederick Fraley,
James S. Whitney,
James Dougherty,
Washington Jones.

4. *On Publications.*

Coleman Sellers,
Bloomfield H. Moore,
Samuel Sartain,
Charles Bullock,
Pliny E. Chase.

Messrs. Bloomfield H. Moore and Charles Bullock were elected Curators for the ensuing year.

The following resolution was adopted, viz:—

Resolved, That the Committee on the New Hall be requested to consider the propriety of soliciting from the Legislature of Pennsylvania the right to occupy the south-western angle of the Penn

Squares in this city, for the purpose of erecting thereon a New Hall, with power to act; the assent of the Institute being first obtained.

At the stated meeting held February 10th inst., donations to the Library were received from the Royal Astronomical Society, the Chemical Society, and the Society of Arts, London, England; l' Academie des Sciences, Paris, and la Société, Industrielle, Mulhouse, France; the Water Commissioners of Jersey City, New Jersey, and Professor Henry Morton, Philadelphia.

The various Standing Committees presented their minutes.

The regular report of the Resident Secretary on Novelties in Science and the Arts was then read.

New business being then in order, it was on motion

Resolved, That the Committee on the New Hall be directed to make applications to the Legislature for the use of one of the Penn Squares for the erection of a building.

It was also on motion—

Resolved, That the President and Secretary be requested to make application to the Senate and House of Representatives of the United States for the appropriation of funds to provide for observations of the total eclipse of the sun in August next. The money to be expended under the direction of the Chief of the Bureau of Navigation, or of the Superintendent of the Coast Survey.

After which, the meeting on motion, adjourned.

HENRY MORTON, *Secretary.*

Complementary Colors by Reflected and Transmitted Light, are admirably shown by a simple arrangement, to which our attention has been called by Prof. C. Pickering, of Boston. A plate of glass is coated with a layer of the violet colored ink, made from aniline color, now much used, and this fluid is allowed to dry upon it. If we then place this in such a position that light is reflected from its surface to our eyes, it will appear of a metallic golden color, as though coated with a gold bronze; but if we look through it at the light, the color will be a very rich purple. There are many other bodies having a similar action, but in none that we know of, is it so striking as in this. Thus, glass flashed with silver, has a green color by reflected, and an orange red by transmitted light. Salts of the sesquioxide of chromium, which are green by reflected are red by transmitted light, a solution of ordinary litmus is blue by reflected but red by transmitted light.

A COMPARISON *of some of the Meteorological Phenomena of* FEBRUARY, 1869, *with those of* FEBRUARY, 1868, *and of the same month for* EIGHTEEN *years, at Philadelphia, Pa.* Barometer 60 feet above mean tide in the Delaware River. Latitude 39° 57½′ N.; Longitude 75° 11¼′ W. from Greenwich. By JAMES A. KIRKPATRICK, A. M.

	February, 1869.	February, 1868.	February, for 18 years.
Thermometer—Highest—degree.....	61·00°	52·00°	70·00°
" date.....	13th.	20th.	23d, '60.
Warmest day—mean ..	50·83	42·67	59·30
" " date.....	13th.	21st.	25th, '57.
Lowest—degree.....	15·00	3·00	—1·00
" date.....	28th.	23d.	7th'55;8th,'61
Coldest day—mean	22·17	12·83	—4·50
" " date	28th.	23d.	6th, '55.
Mean daily oscillation...	12·21	16·00	13·53
" " range.....	5·27	7·84	7·10
Means at 7 A. M.	34·04	21·72	29·58
" 2 P. M.	41·79	31·21	38·49
" 9 P. M.	36·91	26·72	33·80
" for the month....	37·58	26·55	33·96
Barometer—Highest—inches.....	30·457	30·748	30·970
" date.....	25th.	1st.	11th, 67.
Greatest mean daily pressure	30·402	30·672	30·862
" " " date...	25th.	23d.	11th, '67.
Lowest—inches	28·984	29·566	28·984
" date.....	4th.	6th.	4th, '69.
Least mean daily pressure...	29·235	29·633	29·227
" " " date...	4th.	28th.	16th, '56.
Mean daily range.....	0·296	0·278	0·232
Means at 7 A. M	29·908	30·197	29·947
" 2 P. M	29·886	30·154	29·902
" 9 P. M	29·931	30·156	29·932
" for the month	29·908	30·169	29·927
Force of Vapor—Greatest—inches	0·367	0·231	0·549
" date	15th.	21st.	16th, '57.
Least—inches.....	·047	·038	·013
" date.....	28th.	23d.	6th, '55.
Means at 7 A. M.....	·158	·100	·140
" 2 P. M.....	·161	·121	·157
" 9 P. M.....	·160	·121	·157
" for the month...	·160	·114	·151
Relative Humidity—Greatest—per cent	96·0	95·0	100·0
" date.....	15th.	27th.	Often.
Least—per cent....	29·0	42·0	20·0
" date.....	18th.	19th.	22d, '64.
Means at 7 A. M....	75·1	80·0	78·3
" 2 P. M....	58·1	67·1	63·0
" 9 P. M....	70·4	79 5	75·0
" for the month	67·9	75·6	72·1
Clouds—Number of clear days*.	8·	11·	8·4
" cloudy days	20·	18·	19·7
Means of sky covered at 7 A. M	60·0 per ct	64·5 per ct	60 8 per ct
" " " 2 P. M	59·6	50·7	60·5
" " " 9 P. M	43·2	47·9	48·3
" " for the month	54·3	54·4	56·5
Rain and Melted Snow—inches.....	4·49	2·59	3·306
No. of days on which rain or snow fell..	12·	6·	9·9
Prevailing Winds—Times in 1000.....	s59°52′w.244	s77°48′w.240	s75°41′w.271

* Sky one-third or less covered at the hours of observation.

A COMPARISON *of some of the Meteorological Phenomena of the Winter of* 1868–69, *with that of* 1867–68, *and of the same Season for* EIGHTEEN *years, at Philadelphia, Pa.* Barometer 60 feet above mean tide in the Delaware River. Latitude 39° 57½′ N.; Longitude 75° 11¼′ W. from Greenwich. By JAMES A. KIRKPATRICK, A.M.

	Winter, 1868–'69.	Winter, 1867–'68.	Winter, for 18 years.
Thermometer—Highest—degree	61·00°	52·50°	71·00°
" date	Feb. 13.	Dec. 27.	Dec. 2, '59.
Warmest day—mean	51·67	47·33	62·80
" " date	Jan. 9.	Dec. 28.	Dec. 19, '56
Lowest—degree	13·00	3·00	—9·00
" date	Dec. 25.	Feb. 23.	Jan. 8, '66.
Coldest day—mean	20·33	12·83	—1·00
" " date	Dec. 24.	Feb. 23.	F·7'55; F8'61
Mean daily oscillation	11·17	13·21	12·47
" " range	5·11	6·60	6·62
Means at 7 A. M.	32·84	26·27	29·74
" 2 P. M.	38·87	32·86	37·39
" 9 P. M.	35·14	29·45	33·09
" for the Winter	35·62	29·53	33·40
Barometer—Highest—inches	30·489	30·748	30·970
" date	Dec. 13.	Feb. 1.	Feb. 11, '67.
Greatest mean daily pressure	30·415	30·672	30·862
" " " date	Dec. 13.	Feb. 23.	Feb. 11, '67.
Lowest—inches	28·984	29·291	28·941
" date	Feb. 4.	Jan 1.	Jan. 23, '53.
Least mean daily pressure	29·235	29·450	29·086
" " " date	Feb. 4.	Jan 1.	Jan. 23, '53.
Mean daily range	0·251	0·268	0·223
Means at 7 A. M.	29·975	30·082	29·956
" 2 P. M.	29.953	30·056	29·915
" 9 P. M.	29·984	30·082	29·944
" for the year	29·971	30·070	29·938
Force of Vapor—Greatest—inches	0·367	0·361	0 551
" date	Feb. 15.	Dec. 27.	Dec. 2, '59.
Least—inches	·047	·038	.013
" date	Feb. 28.	Feb. 23.	Feb. 6, '55.
Means at 7 A. M.	·143	·121	·138
" 2 P. M.	·144	·126	·155
" 9 P. M.	·153	·134	·152
" for the Winter.	·147	·127	·148
Relative Humidity—Greatest—per cent.	96·0	95·0 p. c.	100·0
" date	Feb. 15.	Jan. 21; F.27	Often.
Least—per cent.	29·0	30·0	20·0
" date	Feb. 18.	Jan. 24.	Feb. 22, '64.
Means at 7 A. M.	72·9	79·7	78·2
" 2 P. M.	58·5	65·6	64·9
" 9 P. M.	72·0	78·1	75·3
" for the Winter.	67 8	74·5	72·8
Clouds—Number of clear days*	24·	25·	26·31
" cloudy days.	66·	66·	64·2
Means of sky covered at 7 A. M.	64·7 p. c.	65·0 p. c.	62 5 p. c.
" " " 2 P. M.	61·7	60·5	62·2
" " " 9 P. M.	45·7	50·9	48·6
" " " for the Winter.	57·4	58·8	57·8
Rain and melted snow—Amount—inches	11·99	8·94	10·279
No. of days on which rain or snow fell	31·	31·	30·9
Prevailing Winds—Times in 1000	N66°37′W.252	S72°3′W.235	N66°50′W.285

* Sky one-third or less covered at the hours of observation.